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# THE JOURNAL OF ECONOMIC BIOLOGY.

Edited by

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.,

*Foreign Member of the Association of Economic Entomologists, Washington, U.S.A.; Honorary Secretary of the Association of Economic Biologists; Honorary Consulting Zoologist to the Land Agents' Society, and the Midland Reafforesting Association; late Special Lecturer on Economic Zoology in the University of Birmingham; and Director of The Cooper Research Laboratory, Berkhamsted,*

With the co-operation of

Professor A. H. REGINALD BULLER, D.Sc., Ph.D.,
The University of Manitoba, Winnipeg.

Professor GEO. H. CARPENTER, B.Sc., M.R.I.A.,
The Royal College of Science, Dublin.

ROBERT NEWSTEAD, A.L.S., F.E.S.,
Liverpool School of Tropical Medicine.

AND

A. E. SHIPLEY, M.A., F.R.S.,
Christ's College, Cambridge.

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*Professor of Zoology in the Royal College of Science for Ireland, and Consulting Entomologist to the Royal Dublin Society.*

ROBERT NEWSTEAD, M.Sc., A.L.S., F.E.S.,

*Lecturer in Entomology and Parasitology in the Liverpool School of Tropical Medicine, and Hon. Lecturer on Economic Entomology in the University of Liverpool.*

AND

A. E. SHIPLEY, M.A., Hon. D.Sc. (Princeton), F.R.S.,

*Fellow and Tutor of Christ's College, Cambridge, and Reader in Zoology in the University.*



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THE

# JOURNAL OF ECONOMIC BIOLOGY.

## THE BIOLOGY OF POLYSTICTUS VERSICOLOR (Fries).

By

JESSIE S. BAYLISS, M.Sc. (Birm.).

WITH PLATES I AND II.

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### 1.—INTRODUCTION.

*Polystictus versicolor* (Fries) is one of the numerous fungi which cause the rotting of wood. Its small fruit bodies are to be found during most months of the year on dead logs lying in moist situations; but under the climatic conditions of England it is especially during the autumn months, and thence onward to late spring, that they appear in great abundance. The fungus is one of the most familiar objects to the field mycologist, but its life-history and ecology seem, hitherto, to have been neglected (Pl. I, fig. 1).

The tough, leathery, neutral-tinted and velvety-topped fruit bodies or sporophores are never more than 4 or 5 cms. across, and unless occurring in great masses form quite inconspicuous objects. These horizontally projecting bracket-like sporophores, semi-circular in form, are of the dimidiate type, being attached to their woody host

by a broad surface; and sometimes, when climatic conditions are favourable, owing to their densely imbricate manner of growth, their broad attaching bases meet and unite, and then whole sheets, even to a square foot or more in area, may be stripped away from the substratum.

The upper surface of the pileus is slightly depressed behind, and since it is covered with fine hairs looks and feels like velvet; a concentric zoning (Pl. I, fig. 9) of various neutral-toned green, yellow, grey, brown and buff bands is always more or less noticeable: the smooth, flat hymenial surface is white at first, but changes to a deep cream colour, and on drying often presents a bright sheeny appearance. When the fungus grows on the rounded top of a horizontal log, specimens of sporophores resembling an umbrella-shaped species with an almost sessile pileus are frequently found, since in such a position a lateral outgrowth is able to extend from every side of a short stem-like base: also on the sides of nearly vertical logs a form almost resupinate, with the hymenial tubes for the most part reduced to mere grooves, is not uncommon.

The fungus is a pure saprophyte, whose natural habitat is moist dead wood: it seems highly probable that it will grow on almost any kind of wood except that of conifers.

I have found it growing on *Quercus robur*, *Fraxinus excelsior*, *Pyrus aucuparia*, *Salix alba*, *Betula alba*, *Pyrus malus*, *Ligustrum vulgare* and *Crataegus oxyacantha*, and have been able to infect without difficulty small blocks of *Fraxinus excelsior*, *Ulmus campestris*, *Prunus avium*, *Alnus glutinosa*, *Acer pseudoplatanus*, *Aesculus hippocastanum* and *Betula alba*, and have successfully cultivated the fungus from spore to spore.

## 2.—Spores and their Germination.

If a fresh fruit body is placed on a glass slide or paper a plentiful supply of spores is obtained in the course of a few hours: they are best seen macroscopically on black paper, where the numerous little white heaps look like an imprint of the hymenial surface of the sporophore.

Microscopic examination shows each spore to be a colourless oval unicellular body, 5-6 × 2$\mu$, in the protoplasm of which can be distinguished two, or sometimes three, groups of granules (Pl. II, fig. 1).

The spores germinate very readily in ordinary tap water, or even distilled water. Within eighteen hours, at a temperature of 19° C., nearly all become swollen, and quite 50% produce germ tubes, 1, 2, 3, or 4 times their own length, and within three days all will germinate.

The germ tube arises at any position of the spore; sometimes abruptly; but more often it seems merely a gradual tapering prolongation of the spore wall: two germ tubes are frequently put forth, and occasionally, before a germ tube is protruded, a division wall is formed across the swollen spore (Pl. II, figs. 2 and 3).

Germination is not influenced by the presence or absence of light.

2*a*. *Hanging-Drop Cultures*.—In order to observe the further development of the germ tube, and the formation of a mycelium, hanging-drop cultures were made, due precautions being taken to use well sterilized apparatus and culture media. Spores were collected upon sterilized paper on glass slides, and were introduced into the culture by means of a sterilized platinum wire. Since a mere touch of the platinum wire will convey hundreds of spores to a drop, when only a few spores were wanted a series of fractional drop dilutions was made on cover glasses, until at last a dilution was obtained from which cultures containing about 5 or 6 spores each could be made.

The culture media used were distilled water, tap water, 8 per cent. gelatine, 12 per cent. cane sugar, 6 per cent. cane sugar, sections of oak, sycamore, cherry, ash, 5 per cent. witté peptone, 5 per cent. alcohol, vaseline, filter paper, 4 per cent. glycerine, thin boiled starch paste and malt extract solidified with 10 per cent. gelatine.

The malt gelatine afforded a good culture medium. In it spores germinated within thirty-six hours, and within two days produced long narrow septate hyphae rich in protoplasm. The progress of the hyphae was rendered very conspicuous by the gradual liquifaction of the gelatine in their vicinity. After seven or eight days the protoplasm in the hyphae commenced to break up into lengths, separated from one another by empty spaces; and later these protoplasmic lengths again broke up into very short rod-like cells (Pl. II, fig. 4) which are no doubt analogous to the rod-like gonidia observed by Brefeld [1] in the young mycelial hyphae of many *Coprini*, and to the oidia which Falck [2] describes as forming a stage in the life-history of *Collybia tuberosa*, *Hypholoma fascicularis*, and other Hymenomycetes, and again which Buller [3] found to occur in *Polyporus squamosus*.

Several of these rod-like oidia were transferred to other hanging-drop cultures; they germinated immediately, and produced a mycelium, which about the seventh day broke up into oidia just as the mycelium from the spore did. This oidial formation continued for

[1] Brefeld, quoted from De Bary, Fungi, Mycet. and Bact. (Eng. Ed.), 1887, p. 332.

[2] Falck, Beitr. z. Biol. d. Pflanzen, 1902, Bd. viii. Die Cultur des Oidien und ihre Rüchführung in die höhere Fruchtform bei den Basidiomyceten.

[3] Buller, Journ. Econ. Biol., 1906, vol. i, p. 117.

two or three months, after which all the oidia grew out into long thin branching hyphae, among which clamp and H connections were frequent. By the end of another three months the hanging-drop appeared to be drying up, and the mycelial development looked very exhausted, and poor in protoplasm, and contained numerous large bright refractive drops—no doubt oil drops. At this stage the hyphae in many places became much wider and formed large rounded cells, some with a lining layer of protoplasm surrounding a bright refractive drop, others remained empty: this stage was followed immediately by a budding process: small bud-like branches were developed from these large cells, and after the formation of a division wall, cutting them off from the main cell, became free; or these bud-like branches remained attached and cells were budded off from them (Pl. II, fig. 5). These conidia-like cells also had a protoplasmic lining, and contained a large glistening drop. Here again there is a strong resemblance to the conidial and yeast-like forms of oidia which Falck[1] observed occurring in the exhausted cultures of *Collybia tuberosa*. These oval conidia increased in size and then budded again or a division wall was formed across the cell previous to the budding: sometimes the budding went on so quickly that a chain of cells was formed just as is found in actively budding yeast. To one culture containing numbers of these conidia a minute drop of malt wort gelatine was added, and within a few days a rich mycelial development was formed, and within nine days the protoplasm in the hyphae had begun to divide up into short lengths, just as in the first mycelium from the spore. A few of these conidia were transferred to malt gelatine drop-cultures: with some the budding only continued, others put forth germ tubes which became septate, increased in size, and then gave off buds (Pl. II, fig. 6): these buds were much larger than those of the exhausted culture, more often double-celled, were richly protoplasmic, and without a large central glistening drop, although small oil drops were to be seen. These oidia when budded off were colourless, but gradually assumed a pale olive green tint, and sometimes before germinating they surrounded themselves with another cell wall, which had an irregular outline (Pl. II, fig. 6*d*). A similar budding process was observed in a distilled water hanging-drop culture containing many spores, when it was moistened again after having dried up within forty-eight hours of being made, at the stage when many spores had swollen, and just a few had put forth very short germ tubes. Here again the conidial form seems to have arisen owing to starvation.

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[1] Falck, *l.c.*

Cultures in 4 per cent. glycerine and boiled starch paste behaved very similarly to one another. The spores swelled very much and produced very wide germ tubes which became septate: at intervals one or more cells in succession became much swollen, some contained protoplasm, others remained empty; sometimes the ends of short branches swelled out into large round cells (Pl. II, fig. 10). A similar arrangement of enlarged cells intercalated in the hyphae were seen in the mycelium inside a pitted duct of mountain ash wood in a very advanced stage of decay, and again it occurred very frequently along the hyphae on an ash culture, which for no apparent reason was not thriving as other ash cultures usually did, and also on a poor culture of horse chestnut.

Both 8 per cent. gelatine and 5 per cent. witté peptone were quite as good media as malt extract solidified with gelatine: in cane sugar (12 per cent. and 6 per cent.) the spores died, apparently owing to plasmolysis: no germination took place in 5 per cent. alcohol or in vaseline: in 5 per cent. glucose the spores germinated within twenty-four hours.

The cultures in which were placed minute chips of oak, sycamore, cherry, ash and alder did not prove very successful: the spores germinated and produced a poor mycelium, whose hyphae could be distinguished penetrating walls or going through pits. These cultures stopped growth after a few weeks; nor was insufficient aeration the cause, for occasionally and momentarily raising the cover glass brought about no further growth.

In the cherry chip culture the mycelium was chiefly produced in the pitted vessels of the chip: a brown resinous substance, probably some degradation product, made its appearance also.

No chemotropic stimulus could be attributed to the wood, for germ tubes continued to grow in whatever direction they started growth, no matter the position of the chip.

2*b*. *Flask and Tube Cultures*.—Cultures in flasks and test-tubes, filled to one-fourth their depth with 8 per cent. gelatine, were observed for six months. The fungus behaved just as in the hanging-drop cultures: the gelatine was gradually liquified, and presented a white cloudy appearance; beginning first at the surface, where the infection was made, and progressing downwards. After two months all the mycelium had broken up into oidia; four months later the oïdial form had passed over to the mycelial form, although a few oidia were still to be seen. Each culture after being examined was attacked by *Pencillium*, and so had to be discarded.

Flask cultures using 4 per cent. glycerine were under observation

for more than twelve months, but only an extremely spare growth of mycelium appeared. This mycelium was similar to that seen in the hanging-drop cultures, that is, many of the hyphae were abnormally wide and very vacuolate, and large rounded cells containing a bright glistening drop were frequent: it seems very probable that these abnormal hyphae are merely involution forms, due to 4 per cent. glycerine being an unfavourable culture medium (compare page 3). After nine months numerous black spots were visible in the mycelium: microscopic examination showed that these were centres at which olive green conidia (Pl. II, fig. 10) were being budded off from, or intercalated in, the hyphae of the mycelium: these conidia were similar in appearance and behaviour to those previously mentioned as occuring in exhausted hanging-drop cultures, and like them when transferred to small wooden block cultures were capable of infecting and thriving on the wood. In the malt gelatine flask and tube cultures a luxuriant growth of white mycelium appeared, which in four weeks liquified the whole of the culture medium (3 cms. deep): but here the mycelium formed a dense felt-work on the top of the liquid, instead of permeating the whole of it as in the gelatine cultures: also, in marked contrast to the continued oidial formation seen in the gelatine cultures, no oidial devolopment could be detected. No sporophore formation appeared; but after eight months numerous small round black patches, 2 or 3 mm. in diameter, appeared on the surface of one culture, and when these were examined microscopically they proved to be centres at which were being budded off olive green conidia, similar to those already mentioned. The frequent occurrence of olive green conidia suggests that perhaps this stage of the fungus may be identified with some species of the genus *Cladosporium*—one of the Hyphomycetes.

2c. *Wood block Cultures.*—Cultures were made on small blocks of wood (3.5 cm. × .9 cm. × 2 cm.), cut from large blocks of heart wood of oak, ash, alder, horse-chestnut, larch, pine, mountain ash, birch, elm, and sycamore.

The method used was that devised by Marshall Ward[1] for cultures of *Stereum hirsutum*: the blocks, after being soaked in cold water for a few hours, or boiled for a short time, in order to be made thoroughly sodden, were placed in short glass cylinders (15 cm. × 3 cm.) plugged at each end with sterilized cotton wool (Pl. I, fig. 11). After heating three times in a steam sterilizer, they were then placed upright in large glass beakers; the upper plug was momentarily re-

[1] Marshall Ward, On the Biology of *Stereum hirsutum*. Phil. Trans. Roy. Soc., 1897, vol. 189 B, p. 123.

moved, and spores from a spore deposit were transferred to the block by means of a sterilized platinum wire. In the *Stereum hirsutum* cultures of Marshall Ward, instead of spores, mycelium from a gelatine culture was transferred to the culture block. The cultures were kept moist by pouring a few cubic centimetres of tap water into the beaker supporting the cylinders: the lower plug in this way was kept continually moist, and although the water used was not sterilized the cultures generally remained quite free from pollution by bacteria and other intruders. If the infection was successful, after about six or seven days a trace of white mycelium could be seen on the outside of the block; and this, extending in all directions, gradually produced a thin white felt-work, varying in thickness from a mere film to two or three millimetres; but only in very few cultures during nineteen months did it quite hide the wood substratum. Growth was best at a temperature of about 15° C.

Ash, mountain ash, horse-chestnut, sycamore, and birch were very readily attacked by the fungus, but alder, elm, and oak proved far more resistent, and often only after several attempts did these blocks yield to infection, and even then the fungus did not seem to thrive well. Larch and pine, and any wood protected on all sides by bark, resisted all efforts at infection: spores germinated on the blocks, and a filmy patch of mycelium could be distinguished after seven days, but there was no further growth. Spores would not germinate on blocks which had been soaked for a week in creosote. Three months after infection one or two very small creamy waxy-looking hemispherical bosses, covered with short hairs, usually made their appearance on the ash, sycamore, horse-chestnut and birch blocks, and colourless or yellow watery faintly acid exudations were frequently seen either on the bosses or near: some of the bosses attained a height of 4 mm., but more frequently were smaller. Occasionally the bosses extended, and so formed ridges, 6 or more mms. in length, with a height of 1½ mms. Often, after a few weeks, these bosses and ridges turned brown, and no further development took place. Other bosses appeared, and this continued for months, and still there were no signs of a typical bracket form of fruit body; although it seemed highly probable that these bosses were efforts at fruit formation, since they were so very similar to the initial stage of a sporophore boss formed under natural conditions.

Several of the blocks were removed from the cylinders into more spacious sterilized damp glass chambers and placed either on cotton wool or sand, and in as bright a light as it was possible to obtain in the laboratory. This environment seemed a little more favourable, since

the next bosses that were formed were slightly larger, and here and there a boss developed with a depression just at the lower side of its apex, thus resembling the second stage of the sporophore formed under natural conditions (Pl. II, fig. 12*b*). This went on for five or six weeks, and still no true bracket form appeared. The covers were now left off the chambers, and no attempt was made to keep the cultures under sterile conditions.

It seemed very probable that as the cultures were so small an insufficient supply of nutriment might be the cause of no proper fruit formation; so two of the culture blocks (ash and elm) were bound to large unsterilized blocks of the same wood, and placed in large glass damp chambers, while several others were placed out in the open among herbaceous plants, a fairly shady spot being chosen, since the time of the year was August. The large block with the culture of ash attached became infected within a few days, and within a month showed a luxuriant growth of mycelium creeping over it, radiating out in all directions, even to a distance of 5 or 6 cms. Its fan-like spreading mycelium greatly resembled a rich mycelial growth of *Merulius lachrymans*, but without the conducting strands so characteristic of the latter fungus. As yet no sporophore has appeared, and seventeen months have elapsed since the culture started, and nine months since it was attached to the large block. The block with the elm culture attached shows no external signs of infection. But the cultures which were put out in the open, under natural conditions, quickly responded to the change of environment, and one small newly-formed cream wax-like boss appeared on each of the three cultures, and on an ash block there appeared within ten days a very small bracket-shaped sporophore, measuring 7 mm. across, which showed all the characteristic features of *Polystictus versicolor*, and shed spores; and this was seven months after the infection of the block (Pl. I, figs. 2 and 3). It seems probable, therefore, that in nature this fungus can develop from the spore to the fruit body stage in the course of a single season.

On the vertical side of the block a resupinate form, with pores shedding spores, was also formed. Microscopic examination of the block showed that fungus hyphae, to a greater or less extent, were to be found in every part; but, nevertheless, on the whole it still remained hard, and there was no great destruction of wood except in the immediate vicinity of the fruit bodies, while there, holes could easily be scraped in the wood with the finger nail.

It may now be concluded that it was not a deficiency in the supply of nutriment, but the unnatural conditions of growth prevailing

in the laboratory, which prevented the formation of the sporophore. On another culture (mountain ash) six and a half months after infection, when it had been two months out in the open, a very small sporophore (5 mm. × 3 mm.) appeared. Lakon,[1] when recently repeating some experiments of Brefeld, found that the sporophore formation of certain *Coprini* was inhibited by a damp atmosphere; but immediately a stream of air was allowed to pass freely through the culture tubes normal sporophores developed.

On the upper horizontal surface of an ash block, infected about the same date, there appeared a deformed sporophore which shed spores from pores formed on its upper surface. This also had just been ten days out in the open.

Although in all the hanging-drop cultures the mycelium produced from the spore passed through an oidial stage after about eight days, yet only in two instances was any trace of this form found on the many block cultures examined, and even then oidia certainly were not abundant.

Falck[2] considers the oidial form of mycelium as a form especially adapted for living in concentrated solutions, and the ordinary basidial mycelium as a form adapted best for growing on solid substrata, owing to (1) its especial power of dissolving the most resistent plant products, (2) its capacity for absorbing dilute solutions, (3) its conducting power. The culture experiments which have already been described certainly support this view, for in the hanging-drop cultures it was only when a lowering of the concentration of the drop took place, owing to the absorption of food material, that the oidial form passed over into the ordinary mycelial form: in the instances mentioned of oidia appearing on the block cultures, possibly the blocks were unusually sodden, and the spores germinated under conditions similar to those of a hanging-drop.

Some of the olive green conidia from a gelatine culture, and also from a glycerine culture, were transferred to a block: soon the whole of the exterior became covered with green conidia, and from some of these were formed hyphae (green and colourless) which penetrated the wood.

An attempt was made to infect branches of two living trees (birch and apple). A wedge-shaped slit was made in each branch, and a plentiful supply of spores then introduced and the slit bound up. Other branches, after being slit and bound up, were kept as controls. After

[1] G. B. Lakon, Die Bedingungen der Fruchtkörperbildung bei *Coprinus*, Bot. Zeit., Abt. 2, 16th Jan., 1908, p. 25.

[2] Falck, *l.c.*

four months these branches were examined. The spores had germinated, and had produced a very poor mycelial development, but had not penetrated the tissue; except in the case of the birch, where in several of the vessels close to the cut surface involution forms of hyphae had developed.

### 3.—Destruction of Wood.

On all the wood cultures, after a few weeks, the infected areas could very easily be distinguished by a change in colour which took place; for the progress of the mycelium is marked by its bleaching effect. This is very striking on the dark woods of elm and alder and cherry, but even the white wood of ash takes a paler hue. In this production of a "white rot" it somewhat resembles *Polyporus juniperinus* [1] and *Polyporus squamosus*.[2] Wood rotted by *Polystictus versicolor* is eventually so soft that a blunt knife will easily penetrate it, and by slight pressure between the fingers it crumbles up and looks like sawdust. If a piece be broken out of a large block and examined, it is seen that it readily splits into tangential flakes parallel with the annual rings, and that these flakes easily break up again into very small splinters parallel with the long axis of the log. The very white lines and small patches, seen especially on the surface of the flakes, are due to strands of white mycelium.

To gain more minute detail of how the fungus proceeds in its work of destruction the small wood culture blocks and also wood from very rotten logs were examined microscopically. Transverse and longitudinal sections soon revealed that the pitted ducts and medullary rays are the first objects of attack: the plugs of fine hyphae filling the vessels are well shown, both in transverse and longitudinal sections, and even in young cultures, on the dark wood of elm and alder, these could be traced with the naked eye as long white lines in the wood. The splitting of the wood into tangential layers parallel with the annual rings is now explicable, since it is in the spring wood that pitted ducts are most abundant, and thus this direction would prove the line of least resistance to fracture. A similar manner of fracture due to the same cause is seen in wood rotted by *Polyporus sulphureus*.[3] The gradual disappearance of the medullary rays is best

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[1] Von Schrenk, U.S. Dept. of Agric., 1900, Bull. 21. **Two diseases of Red Cedar caused by *Polyporus juniperinus*.**

[2] Buller, *l.c.*

[3] Von Schrenk, U.S. Dept. of Agriculture. **Some diseases of New Eng. Conifers, Bull, No. 25, 1900.**

seen in longitudinal tangential sections (Pl. II, fig. 8*a*), where all stages can be found, beginning with the initial one of corrosion of the walls, to the final stage of nearly a lenticular hole. In later stages the fibres round the vessels and medullary rays are also attacked, and signs of corroded walls riddled with holes, formed by the penetration of the fungus, are everywhere evident (Pl. II, fig. 8*e*). In the final stage the thickening layers of the walls of the fibres are almost entirely consumed, leaving only the middle lamella (Pl. II, fig. 7*d*); and cell contents everywhere are quite wanting. In all directions fungus-hyphae are to be seen ramifying everywhere and perforating walls, sometimes passing through the pits, though absence of these is no hindrance to the penetration of the walls (Pl. II, figs. 7, 8, and 9): in some places there was observed a swelling of the hyphae previous to the perforation of the cell wall (Pl. II, fig. 9), as if a storing of energy had taken place previous to the attack. Francz Drysen [1] notes among the Discomycetes a similar swelling of hyphae previous to penetrating walls, also Miyoshi [2] mentions the occurrence of a similar phenomenon during the penetration of a collodion membrane by *Botrytis cinerea*.

In two very rotten specimens (apple and mountain ash), from branches varying from 6 inches to 1 foot in diameter, a dark brown line marked the limits of the ravages of the fungus: it was due to the presence of brown oily-looking cell contents, probably decomposition products of a resinous nature, although only negative results were obtained when tests (Cu acetate solution, Ferric chloride solution, Rosaline violet and Am. molybdate and AmCl) were made for resin and tannin. This dark brown line, although similar in appearance to the black layer found in wood rotted by *Polyporus squamosus*,[3] or by *Trametes pini*,[4] is not of the same nature, for the latter is formed of mycelial tissue: but it bears a strong resemblance to the brown layers so often seen in transverse sections of sound wood taken from well-pruned fruit trees, which is said to be due to oxidation products; since pruning probably allows a freer access of air to the interior of the stem. Similarly wood penetrated by mycelium would doubtless receive a very abundant supply of air, hence the boundary limiting the attack of the fungus might well be defined by brown oxidation products.

[1] Drysen, J. R.M. Soc., Apl., 1907.

[2] Miyoshi, Die Durchbohrung von Membranen durch Pilzfäden, Pringsh. Jahrb., 1895, vol. 28, p. 281.

[3] Buller, from a paper in preparation for the press.

[4] Von Schrenk, U.S. Dept. of Agriculture, 1900, Bull. 25.

The fungus hyphae are unable to penetrate bark except at the lenticels; hence it is always at a lenticel or place of injury that the first sign of the formation of a sporophore appears; and the bark is so resistent that it is quite possible to obtain a branch which has been rendered nearly hollow, owing to the consumption by the fungus of nearly all the interior.

The very marked change in specific gravity is apparent on handling the rotten wood, which, like most woods well rotted by fungi, feels particularly light in weight. The specific gravity of a block of dry mountain ash changed from .5 to .1, and of dry birch from .65 to .2.

## 4.—Chemical Changes in Rotting Wood.

It is very evident that side by side with these structural alterations great chemical changes take place in the composition of wood. The usual colour tests of phloroglucin and chlorozinc iodine were applied to microscopic and larger portions of sound and decayed wood. With phloroglucin and HCl the rose-red colour was certainly far less pronounced in the rotten than in the sound wood, and in wood in the last stages of decay, whatever fragments of medullary rays did remain were only very faintly stained; so this is evidence that the fungus removes to some extent the substances, whatever they may be, which cause the so-called lignin reaction. With chlozinc iodine all the elements of both sound and rotten wood stained a beautiful golden brown: now although it might be said, judging from the phloroglucin test, that delignification had taken place, yet no violet colouration indicating the presence of uncombined cellulose could be detected. A few very faint traces of violet colouring were to be seen in fragments of medullary rays of rotten wood after staining for forty-eight hours. Although the substance hadromal, which was first isolated by Czapek,[1] gives the phloroglucin reaction, yet it does not seem quite justifiable to infer that the absence of colouration on applying the phloroglucin test is conclusive evidence that that aromatic aldehyd has been abstracted by the fungus; since many other aromatic compounds have a similar reaction with phloroglucin and HCl.

Also knowing that some unlignified cell walls give the phloroglucin test this colour reaction is hardly a conclusive proof of the presence or absence of lignification. Since colour tests cannot be relied upon, the difference between altered and unaltered wood can hardly be satisfactorily explained without actually isolating and estimating

[1] Czapek, Biochemie der Pflanzen, vol. i., p. 571.

quantitatively the different substances composing the woody tissue—a by no means simple task even in the hands of an experienced chemist, since on the subject of a chemical nature of wood there are still very many differences of opinion. A reference either to Czapek's[1] or Wiesner's[2] summary of the subject, shows that although many substances have been isolated, concerning some it is a matter of much uncertainty whether the substance existed as such in the wood or was merely some compound formed during the chemical reaction.

Von Schrenk,[3] in the course of his investigation of the red rot caused by *Polyporus carneus*, obtained by abstracting finely rasped cedar wood with absolute alcohol for six hours in a Soxhlet's extractor, a substance which he considered identical with hadromal.

Similar extractions were carried out, using finely divided sound and decayed wood. 5.4 gms. of sound fine birch sawdust was extracted with 150 cc. of absolute alcohol for nearly sixteen hours: the extract when tested with phloroglucin and HCl assumed the deep rose-red colour characteristic of lignin, and also of hadromal, and when evaporated down left a brown gummy deposit, in which, when examined microscopically, could be seen a few white transparent needle-shaped crystals, which may have been those of hadromal.

When this experiment was repeated, using decayed instead of sound birch, the extract did not give the phloroglucin reaction, although on being evaporated down a similar gummy deposit remained.

Since according to Potter[4] some of the delignification of wood attributed to fungi has really taken place during the sterilizing process, it was thought well to see to what extent this might possibly have been the case in the small blocks such as were used for the wood culture experiments. 5.4 gms. of birch sawdust (a little culture block weighed about 5.4 gms.) was distilled with 150 cc. of water for twenty hours: the extract did not give the phloroglucin reaction: it was evaporated down, and the brown gummy deposit obtained was redissolved in 3 cc. of water: this liquid gave a very faint rose-red colour when tested with phloroglucin and HCl. Hence, since steaming of wood in a finely powdered state for twenty hours, produces in the extract after concentration only very slight evidence of delignification, the delignification which would take place in a solid block during sterilization (at most $2\frac{3}{4}$ hours steaming) must be very insignificant.

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[1] Czapek, *l.c.*

[2] Wiesner, Die Rohstoffe des Pflanzenreiches, 1900.

[3] Von Schrenk, U.S. Dept. of Agriculture, Bull. 21, p. 17, 1900.

[4] Potter, Ann. of Botany, 1904, On the occurrence of Cellulose in the Xylem of Woody stems.

Spaulding[1] considers that Potter's statement concerning this delignification produced by steaming should generally be modified somewhat.

Since wood is known to contain about 20 per cent. or more of xylan or wood gum, an attempt to extract this substance from sound and rotten birch wood was made. Following the method used by Okmura,[2] 2.5 gms. of sound birch wood sawdust was added to a flask containing 25 cc. of 5 per cent. of KHO solution, and after corking up left untouched, except for an occasional shaking for twenty-four hours: a similar mixture was made, using rotten wood instead of sound: on filtering a clear brown extract was obtained from both flasks, the rotten wood extract being the darker of the two. Both extracts were now neutralized with dilute HCl, until only a very slight acid reaction was perceptible: a copious cream precipitate of xylan came down in the sound wood extract, whereas in the other extract only the merest trace of a turbidity was to be seen. After filtering and drying and estimating the increase in weight of the two filter papers, it was found that the wood gum extracted from the 2.5 gms. of decayed wood was only 50 mgs., compared with 150 mgs. from the sound. Taking into consideration that decay in birch wood brings about a reduction of specific gravity from .65 to .2, the figures showing the amount of wood gum extracted from equal volumes of decayed and sound wood would show a far greater contrast. In a similar experiment, with similar results, alcohol instead of dilute HCl was used to precipitate the wood gum.

It is well known that conifers are exceedingly poor in wood gum, hence possibly to this cause may be assigned their immunity to infection by this fungus: on the other hand birch, which contains as much as 26 per cent. of xylan, falls an easy prey.

## 5.—The Sporophore.

The first sign of the sporophore formation is the appearance of a minute rounded white knob, about the size of a pin head, either at a lenticel, crack, or the cut or broken end of a branch: this knob gradually increases in size until it stands out about 4 or 5 mms. from the bark (Pl. II, fig. 12*a*). A horizontal groove (Pl. II, fig. 12*b*) now appears across the apex of the knob, and in the course of the next twenty-four

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[1] Spaulding, Missouri Bot. Gard., 17th Report, 1906. Studies on the lignin and cellulose of wood.

[2] Okmura, Imp. Univ. of Japan, Coll. of Agric., Bull. 2, 1894-97. Wood Gum in trees (Xylan).

hours the bracket form is made much more pronounced by the greater growth of the upper half of the knob-like structure forming the pileus (Pl. II, fig. 12*c*): at the same time there is a slight flattening of its upper surface, and on the lower can be seen four or five very shallow pits, which ultimately develop into hymenial tubes (Pl. I, fig. 10): under favourable conditions this stage is reached in five or six days. The part below the groove either ceases growth or extends radially over the bark, and often unites with the bases of other sporophores formed below or at the sides: its exposed surface becomes dotted over with pit-like depressions, which on further growth become grooves: the pileus develops into the semi-circular zoned structure already described, and grows by additions to its margin (Pl. I, fig. 9). At the same time the pits which cover the under surface to within .5 mm. of the margin develop into hymenial tubes: the thickness of the pileus varies from about 4 or 5 mms. behind where the tubes are formed to 1 mm. or less at the margin where there are no tubes. The hymenial tubes vary in depth from 1.5 or 2 mm. to mere depressions: very long tubes, of a depth of even 5 mm. or more, are sometimes formed.

The rate of growth of the pileus varies according to temperature and supply of moisture. With a temperature of 60° F. and a saturated atmosphere—highly favourable conditions for growth—an average of 1 mm. a day is attained: at a lower temperature of 50° F. the average growth does not exceed .5 mm. a day, and at a temperature whose maximum and minimum does not vary much from 40° F. the growth is very slow, 1 mm. in five or six days. During frosty weather growth is entirely arrested. A sporophore takes about six months to complete its growth; but it is difficult to know when this final condition is reached, for growth is often arrested for a month or six weeks at a time when conditions are unfavourable: also injuries by beetles, and probably birds and rodents, who find it a convenient source of food, will cause sporophores to stop growing.

The zoning of the pileus seems due chiefly to an alternate checking or promotion of growth caused by changes in the amount of moisture, this of course being dependent on varying atmospheric conditions. A sporophore-bearing branch of birch was arranged with one end dipping in a few cubic centimetres of water in a beaker; this was placed in a dish also containing a little water, and the whole was covered with a bell jar; the temperature did not vary more than a few degrees from 15° C. Hardly any signs of zoning could be traced on the pilei which developed under these conditions, and the velvety surface instead of having the usual ribbed appearance was quite even. Occasionally the bell jar was left off for an hour, and even this slight

exposure to a drier atmosphere was sufficient to cause a check in the growth, and hence a marked zone in the pileus. Pilei growing on logs in fields and woods were watched and measured at intervals of a few days, and always after a period of drought, during which growth was quite or nearly arrested, a distinct furrow or zone marked the end of the old zone and the beginning of the new: sometimes when the period of drought had been prolonged a week or more, in a vertical radial section through the pileus the division line could be seen, extending nearly to the hymenial surface. When atmospheric conditions were unfavourable to growth, the hairs forming the velvety surface were either exceedingly short or none were developed; hence a period of drought was marked by a furrow. The faint zoning which occurs when apparently there has been no great change in the humidity of the air is doubtless due to the check in growth which takes places at night owing to a fall of temperature.

The colouring, which to some extent intensifies the zoning, is dependent on light: it is due to the presence of a diffuse yellowish pigment, which on exposure to light gradually changes into sepia brown granules. When the sporophore makes its first appearance it is always white, as is also any new growth which takes place at the margin of the pileus: after three or four days a pigment is developed in the hairs which cover the upper part of the sporophore, and also in the surface strands of hyphae from which these hairs arise: these pigment granules cause the hairs and superficial hyphae to vary from buff to dark brown, according to the intensity of light. The sporophores grown in the diffused light of the laboratory, under uniform conditions of temperature and moisture, were a uniform pale buff colour: only very rarely was a zone emphasized by a slight deepening of colour, and any zoning that did occur was only very faintly marked, and could be accounted for by differences of day and night temperature.

Sporophores which developed in the open on the lower side of a huge log, shaded by over-arching trees, also had pale buff upper surfaces; but the zoning was well marked, since the variable atmospheric conditions had been responded to by variations in the growth of the hairs. On the same log the sporophores which grew on the top, and on the under side, where they were exposed to a greater intensity of light, developed quite normally, and the buff colour soon changed to the darker brown shade. If growth is checked rather quickly, the margin of that zone of growth, owing to a deficiency in the formation of pigment, is marked by a lighter band; hence the pilei formed in summer, when periods of drought are more frequent, and growth is

often arrested suddenly, generally have many golden brown bands marking these periods.

This yellow pigment is at first diffused through the sap; but later on, when it changes to the darker sepia brown shade, it takes a granular form, and then the hairs and superficial hyphae have the appearance of thick-walled tubes containing a core of sepia brown granules. It is only the fairly young zones of a pileus which show these conspicuous coloured bands, for ultimately the whole surface acquires the same dark colour; and the banded appearance seen then is due only to the differences of texture presented by the velvety ridges and satiny furrows, which become even more conspicuous when the pileus, on becoming quite dry, has the well-known grey appearance. A pale buff-coloured pileus, when once detached from its host and allowed to dry for some weeks, is incapable of developing the darker pigment when exposed again to ordinary atmospheric conditions.

This dark brown pigment is unaltered by $H_2SO_4$, HCl, or ammonia, but nitric acid changes the colour to brick red: it is slightly soluble in absolute alcohol.

The green zones so often seen are caused by the presence of colonies of *Pleurococcus vulgaris* [1] and *Stichococcus bacillaris* [1] among the hairs on the surface of the pileus.

The biological significance of these velvety hairs, which also occur on the upper surface of the pilei of many species of fungi, is a matter of doubt. According to Buller [2] they form a kind of capillary system for the purpose of rapidly spreading any drops of water which may fall on the pileus; and certainly a drop of water let fall on a pileus does disperse almost instantaneously. Or, they may be of the same use as the hairs of many xerophytic plants, which are in this way afforded protection against rapid desiccation; and in support of this it may be mentioned that a pileus stripped of its hairy surface dries up far more rapidly than it otherwise would do.

Microscopic examination of a pileus showed that it consisted of a densely-woven felt-work of branching septate hyphae, radiating from the attaching base. At the upper horizontal surface many hyphae became free, and formed the characteristic long pigment-containing hairs: other hyphae grew vertically downwards, and formed the hymenial tubes. Some of the largest hyphae measured $3.7\mu$ in diameter. The hymenial tubes were lined by club-shaped basidia (Pl. ii, fig. 11), from each of which were developed four spores attached to the ends of rather long sterigmata.

[1] Kindly identified by Mr. Geo. S. West, M.A.

[2] Buller, in a communication to the Royal Society, not yet published.

Basidia are produced, and spores shot off from the sterigmata, immediately the hymenial tubes begin to form; the tubes always grow vertically down, so that the openings are usually round, but they may be oval, or even groove-like, if the tubes arise from an oblique or nearly vertical part of the pileus.

### 6.—Reactions of the Fruit Body to Light and Gravity.

Light and gravity play a very important part in determining the development and direction of growth of the fruit bodies of many fungi—of *Polyporus squamosus*, *Lentinus lepideus* and others, so that it is not surprising to find that the combined action of the two stimuli is necessary for the formation of a properly formed fruit body in this case also.

Two small branches of birch, with fruit bodies already developing on them under normal conditions, were brought into the laboratory and placed in similar damp chambers: one was placed in the dark room, and the other, kept in the light, was used as a control. The already-formed fruit bodies ceased to grow, and in the course of a month several new ones began to develop on both branches, and in addition, on the control branch a small fruit body developed on the edge of an old pileus. These observations were continued for nine months, and never during that time did a proper bracket form of pileus appear on the branch in the dark chamber. Large numbers of white wax-like bosses, which grew to an abnormally large size, were developed over a long period, and after assuming a creamy or greyish velvet-like appearance ceased to grow (Pl. I, fig. 4). Some of these large bosses were from 1.3 to 1.5 cms. in diameter, and projected out 1.6 cms., while normal ones never measured more than one-third of these dimensions. A few of the bosses became slightly depressed at the apex, but no trace of any pore or tube formation was seen. When this branch was moved into a light chamber new bosses continued to form, but these developed into typical fruit bodies in the course of a few days (Pl. I, fig. 5). None of the bosses which had been formed in the dark grew into pilei, no matter the stage of development at the time of the change from darkness to light. On the control branch the small wax-like bosses developed into small normal bracket-like sporophores, but these were paler in appearance and had their zoning less marked than similar fruit bodies grown out in the open air. This experiment points to light being the controlling factor in determining sporophore production; but then no account has been taken of the action of gravity—the importance of which is seen in the results of the following experiment.

Two small mountain ash branches very similar to the above, bearing normally developed fruit bodies, were arranged horizontally, one on a clock-clinostat,[1] the other as a control. Here an environment more nearly approaching a natural one was secured by allowing the branch on the clinostat to project through a hole in the laboratory window, thus while the clock work of the clinostat was protected, the branch had all the advantages of ordinary atmospheric conditions. To obtain a further and more continuous supply of moisture than the rather exposed, and thus dry, situation afforded, an apparatus was made for allowing two drops of water to fall on the branch every three or four minutes, and this was connected by means of a syphon with a small tank of water in the laboratory. The control branch was fixed to the window woodwork a little below the other, and shared in the falling drops of water. The branch on the clinostat rotated three times every hour, and the experiment was continued for seven months; but never during this period did a typical bracket-shaped fruit body form: small white waxy bosses appeared, which spread irregularly in all directions, and sometimes united with one another: these formed eventually an incrustation over the surface of the branch with a rough irregular surface and curled up edges (Pl. I, fig. 6). The white waxy bosses soon turned cream colour and showed signs of a pore formation on the exposed surface, while the surface next to the bark assumed the velvety zoned appearance so characteristic of the upper surface of a normal pileus; a small piece of the pore-bearing part, laid on a glass slide for an hour, yielded a good supply of spores. On the control branch a well-developed series of imbricate sporophores appeared.

Taking into consideration these two experiments, it seems quite evident that the dimidiate form of the sporophore is not to be ascribed either solely to the stimulus of light, nor yet to that of gravity, but to the combined action of both, while it is very evident the formation of pores, and thus of spore production, is a response to the one force only—that of light.

### 7.—*Polystictus versicolor* AS A XEROPHYTE.

An observation will now be described indicating that the mycelium of *Polystictus versicolor* can retain its vitality for at least four years.

A large branch of privet (*Ligustrum vulgare*) with fruit bodies of *Polystictus versicolor* upon it, collected four years previously, was taken from the Botanical Museum, where it had been kept dry. The temperature to which it had been subjected varied from about 10° C. in the winter to 19° C. in the summer. The branch was sawn into two

[1] **Bayliss, Galvanotropism of Roots, Ann. of Botany, 1906, p. 389.**

parts, one part with the fruit bodies on it and the other without. The branches were soaked for a day in a large vessel of water, and then placed in a damp chamber (50 cm. × 50 cm. × 50 cm.) and kept watered. In the course of a week the bark became covered with a mycelium: this belonged to various moulds, which on fruiting were identified. Just under a month from the date of soaking a number of small cream-coloured wax-like bosses appeared, studding the surface of both branches; from many of them hung pale yellow watery exudations, faintly acid to litmus. After a week or two several projected as far as 6 or 7 mms. from the bark, and also showed indications of the bracket form of pileus characteristic of *Polystictus versicolor*; but on reaching this stage these imperfect sporophores turned brown and ceased growth: these were followed by other similar wax-like bosses, which on reaching the same stage also died. One of the branches was now put out in the open on damp moss, and in a few weeks normal dimidiate sporophores developed on it. The branch left in the laboratory, in about three months from the date of its removal from the museum, produced an abnormal bracket form of fruit body with pores on the upper surface; also another strange-looking structure—a series of five or six undeveloped brackets, growing one out of the other, and projecting like a rod (Pl. I, fig. 8). The light in the laboratory in which these were growing is not good in the darker months of the year, so this may account to some extent for these abnormalities; a few weeks later, as the days grew lighter, in February, a proper typical well-developed sporophore, with concentric zoning, velvety surface and tubular hymenium appeared (Pl. I, fig. 7). It is very evident that the mycelium of *Polystictus versicolor* must retain its vitality after prolonged and continuous desiccation: in the above instance, in four years the mycelium had not died. The contention might be raised that stray spores of *Polystictus versicolor* on the bark had germinated, and in this way the branch had been reinfected; but such an explanation can hardly hold good if one calls to mind the small block culture experiments which have already been described in detail, and remembers that the first sign of sporophore production did not appear until at least three months after infection; and even when typical sporophores did appear, they were only of very small dimensions. Yet another explanation might be urged: since oidium-like cells have been seen among the hyphae in wood vessels, may not these cells be adapted to resist prolonged drought just as spores are? But then again they were not by any means abundant in the dry specimens of rotten wood examined, so it is hardly to be believed that the mycelium, which was in a good fruiting condition within a month of the dried branch being

placed under damp conditions, was developed solely from these structures. This instance of great vitality in mycelium is not without a parallel case, for Falck [1] mentions that horse dung infected with the mycelium of *Coprinus sterquilinus* was capable of infecting other cultures after being kept perfectly dry for a year. Again, the blocks of ordinary mushroom spawn sold in shops are usually quite dry, and probably have been kept so for long periods, and still the mycelium retains its vitality. Since mycelium possesses this power of retaining its vitality, even after four years' drying, it is evidently highly important that timber used for economic purposes should be well tested as to its soundness, and if possible some sterilizing treatment adopted before using, otherwise any access of moisture would cause a further development of the fungus and renewed rotting of the wood. Often in the course of this investigation block after block of apparently sound hard wood, especially birch, had to be discarded, because on being examined microscopically it was found to be already infected. Of course, the sterilizing process would have prevented any of the mycelium developing further, but any blocks thus affected would have been vitiated for microscopic examination afterwards.

Buller [2] has made known the fact that very many of the leathery and woody forms of sporophores, such as *Polyporus*, *Daedalia*, *Fomes*, etc., after prolonged drying, are capable when moistened of reviving and shedding spores again: in some instances, the sporophores which revived had been dry for several years. The sporophores of *Polystictus versicolor* also possess this power of reviving: sporophores which had been dried for sixteen months, and were perfectly hard and rigid, on being thoroughly moistened revived in 3½ hours. And apparently the same sporophore is capable of reviving again and again after drying and becoming quite hard, for several which were tested revived as many as six times. But specimens four years' old, removed from the branch whose mycelium revived, had lost their vitality entirely.

Under natural conditions the hymenial surface of the pileus does not often last longer than a few months owing to the ravages of a little beetle (*Cis boleti*, Scop.), which delights in consuming its substance, whether moist or dry. Even gathered sporophores, unless special care had been taken to pick only perfectly sound ones, after a few months will be found entirely consumed with the exception of the velvety upper surfaces.

The spores also retain their vitality for long periods. Spores

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[1] Falck, *l.c.*, p. 317.

[2] Buller, in a communication to the Royal Society, not yet published.

which were kept in the laboratory for eleven weeks always germinated, although drying delayed the germination somewhat longer than the usual period of twenty-four to forty-eight hours: those which had been dried for seventeen weeks would not germinate.

The spores are also capable of germination after exposure to high and low temperatures: those which had been in a temperature of 41° C. for three days germinated in three days, and they also germinated after being exposed for half an hour to a temperature of 75° C, but were not able to survive a temperature of 100° C. After being kept for three days at a temperature of 0° C. in the ice chest of the Chemical Department, spores germinated two days later than those of the same spore deposit kept at ordinary laboratory temperature, but they would not germinate after being frozen for three weeks.

### 8.—Enzymes.

The life-history of a fungus would be very incomplete without some reference being made to its enzymes, for doubtless the gradual decay which a fungus causes in sound wood is to be attributed to the activities of these secretions, in the preparation of easily assimilable food material for the fungus plant. Although in recent years enzymes have received much attention from many investigators the records of their occurrence in fungi are far from numerous.

By means of the usual tests on an extract of *Polystictus versicolor* the presence of laccase, rennetase, cytase, invertase, diastase, coagulase, ereptase and a fibrin digesting protease was demonstrated. Only negative results were obtained on testing for emulsin, lipase, maltase and hadromase.

### 9.—Conclusion.

In conclusion, I must express my thanks to Professor Hillhouse for the kindly assistance he has rendered me in many ways in the course of this work; and also my indebtedness to Professor Buller, both for the subject of this investigation and for the very many helpful suggestions he has given me in carrying it out; and to Professor Adrian Brown for loan of apparatus and material. My thanks are also due to Mr. Herbert Stone for identifying the wood experimental blocks, to Mr. Stoward, M.Sc., for help in the enzyme section of this work, and to Mr. W. B. Grove, M.A., for the identification of some of the fungi.

*University Botanical Laboratory,*
*Birmingham,*
*March,* 1908.

Journ Econ Biology, 1908, Vol. III, pt 1.

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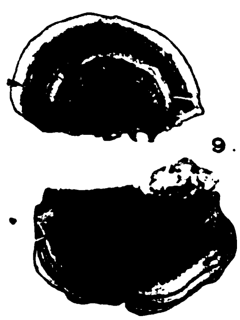

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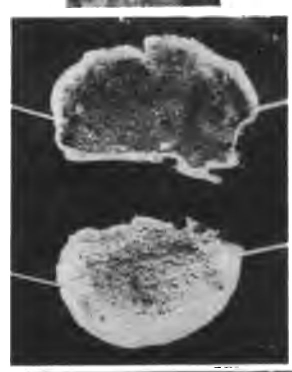

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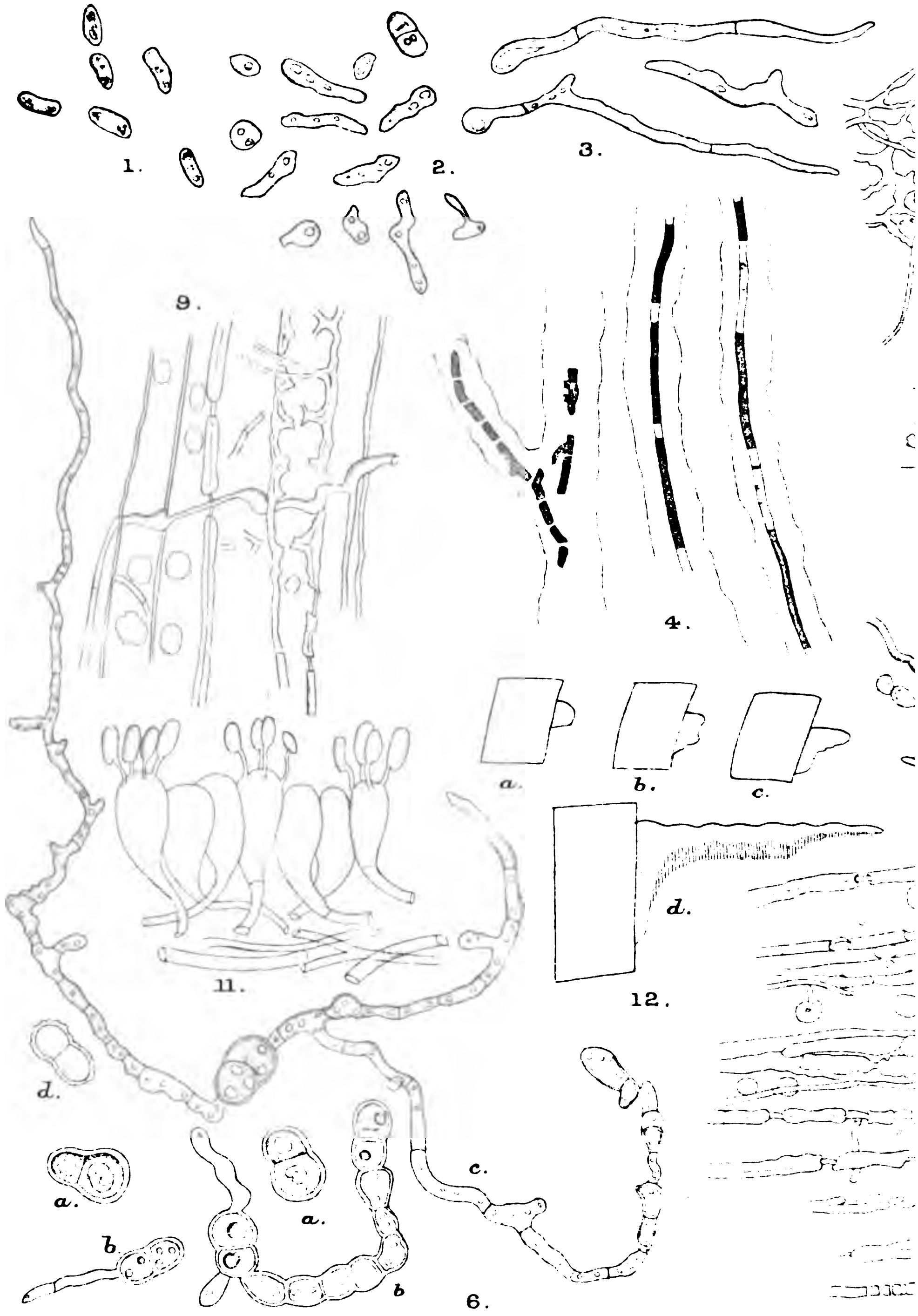


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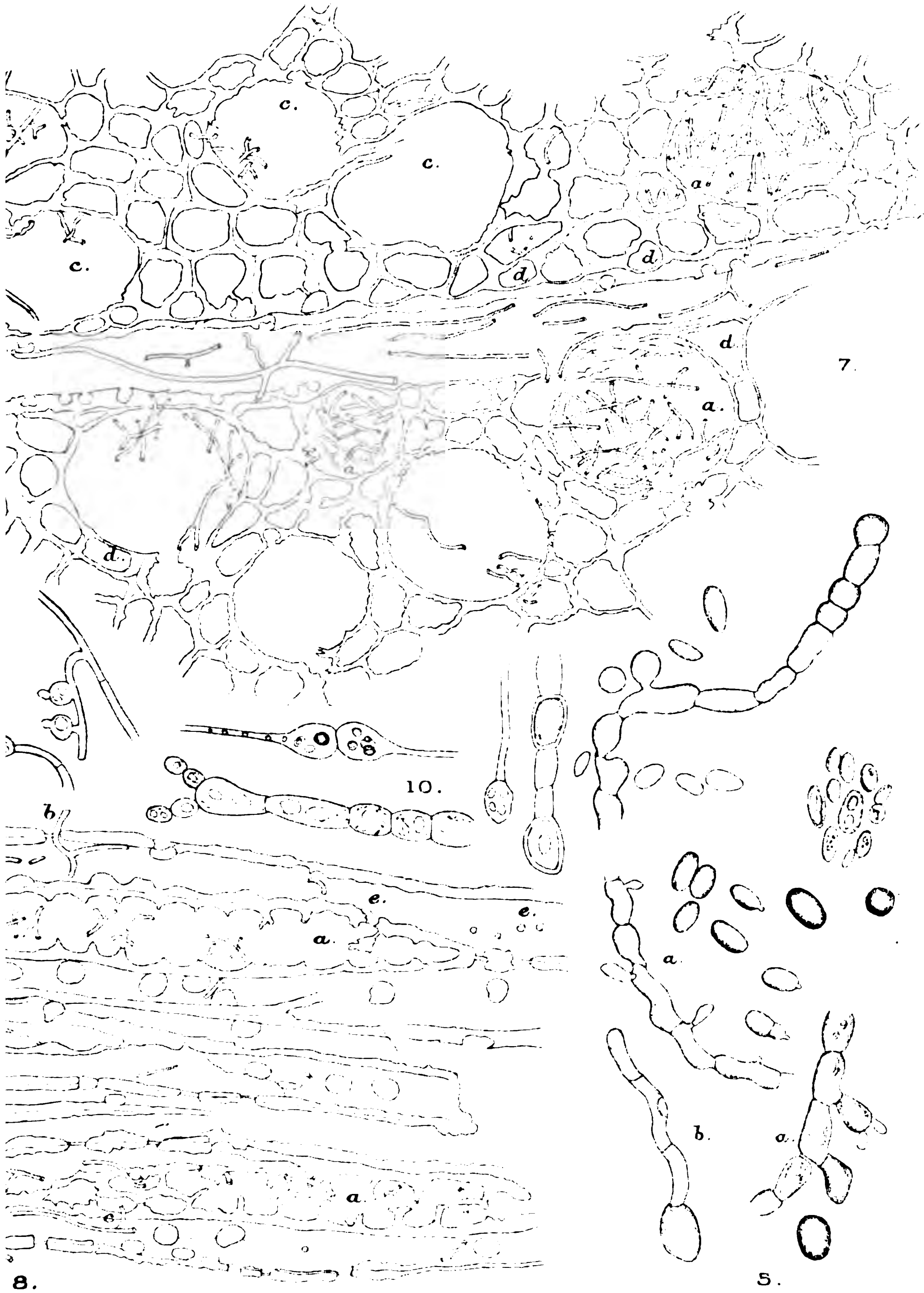


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## EXPLANATION OF PLATES I AND II,

Illustrating Miss Jessie S. Bayliss' paper on "The Biology of *Polystictus versicolor* (Fries)."

### PLATE I.

Fig. 1.—Sporophores of *Polystictus versicolor* growing on a mountain ash log in Sutton Park, 1907.

Fig. 2.—Sporophore grown from spores on a small block of ash.

Fig. 3.—Hymenial surface of the sporophore in fig. 2: the large hole was made by a small beetle.

Fig. 4.—Large sporophore bosses on a branch which has been kept in a dark room for nine months. No trace of hymenium to be seen.

Fig. 5.—The same branch as in fig. 4, a week after being in the light: hymenial surfaces have developed.

Fig. 6.—Abnormal sporophores formed on a branch while revolving on a clinostat: the cork disc and spindle were used for attaching the branch to the clinostat.

Fig. 7.—Pileus (slightly enlarged) developed on rotten branch from mycelium which had retained its vitality for four years in a desiccated condition: numerous young sporophore bosses are visible.

Fig. 8.—The horizontal rod-like structure is a series of sporophores growing one out of the other.

Fig. 9.—Upper surfaces of fruit bodies of *Polystictus versicolor* showing zoning.

Fig. 10.—Lower surfaces of fruit bodies of *Polystictus versicolor* showing the pores of the hymenial tubes.

Fig. 11.—Culture tube containing a wood block which is partly covered with mycelium and on which a young sporophore boss has developed.

### PLATE II.

Fig. 1.—Freshly fallen spores. × 800.

Fig. 2.—Germinating spores after forty-eight hours in tap water. × 800.

Fig. 3.—Germinating spores twenty-four hours later than in fig. 2. × 800.

Fig. 4.—Hyphae from spores grown in malt-gelatine breaking into oidia: the hyphae have liquified the malt-gelatine in their vicinity. × 800.

Fig. 5.—(*a*) Conidia budding from exhausted hyphae. × 1000. (*b*) Germinating conidium with a large glistening drop in the centre.

Fig. 6.—(*a*) Two-celled olive green conidia. (*b*) Germinating conidium. (*c*) Germinating conidium a few days older than (*b*). (*d*) A two-celled conidium surrounded by a rough wall.

Fig. 7.—Transverse section through rotten mountain ash wood. × 800. *a*, *a*, *a*, are vessels blocked with fungus hyphae. *b* is an almost entirely

consumed medullary ray. *c*, *c* are destroyed vessels. *d*, *d*, *d* are walls consumed except for the middle lamella. Corroded walls are everywhere apparent.

Fig. 8.—Tangential section through rotten mountain ash wood *a*, *a*, *a* are nearly consumed medullary rays. *b* is a hypha passing through a pit, *c*, another penetrating a wall. *d* is a large hole made by a fungus hypha. *e*, *e* is a corroded wall. Enlarged pits are very numerous.

Fig. 9.—Section shewing swelling of hyphae previous to penetrating walls.

Fig. 10.—Olive green conidial cells and wide hyphae from the black specks in the glycerine culture. × 800.

Fig. 11.—A portion of the hymenial layer showing basidia and spores.

Fig. 12.—*a*, *b*, *c*, and *d* are sections showing successive stages in the development of a sporophore. Natural size.

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## REVIEWS AND CURRENT LITERATURE.

### I.—General Subject.

**Howard, L. O.**—The Recent Progress and Present Conditions of Economic Entomology. Science, 1907, n.s. vol. xxvi, pp. 769-791.

This is a most interesting review of the progress that has been made since 1894 in economic entomology. To collect the necessary information from all parts of the world must have been no easy task, and whilst we fully agree with Dr. Howard that "official recognition of this science in Great Britain is slight," there is much more work being done than Dr. Howard seems to be aware of. We find no mention of the excellent work of Dr. R. Stewart MacDougall, in Scotland; of the Department of Economic Zoology in the University of Manchester; Mr. Cecil Warburton's work in connection with the Royal Agricultural Society; or that being carried out by The Cooper Research Laboratory.

**Morgan, H. A.**—The Relation of the Economic Entomologist to Agriculture. Journ. Econ. Entom., 1908, vol. i, pp. 11-15.

**Sanderson, E. D.**—The Relation of Temperature to the Hibernation of Insects. Journ. Econ. Entom., 1908, vol. i, pp. 56-65, 2 figs.

**Westell, W. P.**—The Insect Book. Pp. xii. + 120, 36 figs. By R. B. Imisson. London: John Lane. [1908]. Price 3/- net.

This dainty little brochure is one of Mr. Lane's "Country Handbooks" series. At the present time there seems to be a demand for nicely illustrated books, such as this, treating on insects and insect life.

The illustrations are certainly good, but we must confess that we cannot understand anyone who wishes to learn anything about insects turning to such a work as this, when, for a few pence more, he or she can obtain a work like Professor Carpenter's "Insects, their Structure and Life," and possess an excellent and entertaining guide.

We do not say this as in anyway derogatory to Mr. Westell's little work, which is written in an entertaining style, and will no doubt be widely read.

After an introduction, full of interesting facts, the author considers the commonest forms of insects of the garden, the water-side, the woodland, of meadows, heaths, and lanes, and household insects.

W. E. C.

## II.—Anatomy, Physiology, and Development.

**Barber, C. A.**—Studies in Root Parasitism. The Haustorium of *Olax scandens*. Mem. Dept. Agric. India, Bot. Ser., 1907, vol. ii, No. 4, pp. 1-47, plts. i-xii.

**Bugnion, E.**—Polyembryony and the Determination of Sex. Ann. Rpt. Smiths. Inst. for 1906. Washington: 1907, pp. 309-320.
A résumé of the observations of P. Marchal.

**Nieden, F.**—Der sexuelle Dimorphismus der Antennen bei den Lepidopteren. Zeit. f. wiss. Insekten., 1907, Bd. iii, pp. 114-117, 137-143, 165-174, 198-203, 242-247, 39 fign.

## III.—General and Systematic Biology, and Geographical Distribution.

**Adkin, R.**—Life history of *Tortrix pronubana*. Entom., 1908, vol. xli, pp. 49-51, plt. ii.

**Cerva, F. A.**—Biologie der *Eilicrinia cordiaria*, Hb. Zeit. f. wiss. Insekten., 1907, Bd. iii, pp. 53-56, 1 fig.

**Cholodkovsky, N.**—Zur Biologie von *Scardia tessulatella*, Zell. Zeit. f. wiss. Insekten., 1907, Bd. iii, pp. 78-83, 6 fign.

**Donisthorpe, H. St. J.**—The Life-History, and Occurrence as British of *Lomechusa strumosa*, F. Trans. Entom. Soc. Lond., 1907, pp. 415-420, figs. 1-6.

**Eichelbaum, F.**—Die Larven von *Cis festivus*, Panz., und von *E. phylus glaber*, Gyll. Zeit. f. wiss. Insekten., 1907, Bd. iii. pp. 25-30, 8 fign.

**Escherich, K.**—Neue Beobacktungen über *Paussus* in Erythrea. Zeit. f. wiss. Insekten., 1907, Bd. iii, pp. 1-8, 2 fign.

**Felt, E. P.**—Observation on the Biology and Food Habits of the *Cecidomyiidae*. Journ. Econ. Entom., 1908, vol. i, pp. 18-21.

**Fiebrig, K.**—Eine Ameisen ähnliche Gryllide aus Paraguay. Zeit. f. wiss. Insekten., 1907, Bd. iii, pp. 101-106, 10 fign.
*Myrmegryllus dipterus*, n. gen. et sp.

**Hättich, E.**—Ueber den Bau der rudimentären Mundwerkzeuge bei Sphingiden und Saturniden. Zeit. f. wiss. Insekten., 1907, Bd. iii, pp. 229-242, 261-272, 10 fign.

**Hewitt, C. Gordon.**—On a new Phytophagous Mite, *Lohmannia insignis*, Berl. var. *dissimilis*, n. var., with notes on other species of economic importance. Mem. and Proc. Manchester Lit. Phil. Soc., 1908, vol. lii, pp. 1-10, 1 plt.

**Hooker, W. A.**—Life History, Habits and Methods of Study of the *Ixodoidea*. Journ. Econ. Entom., 1908, vol. i, pp. 34-51.

An important and interesting paper.

**Huber, J.**—The Founding of Colonies by *Atta sexdens*. Ann. Rpt. Smiths. Inst. for 1906. Washington: 1907, pp. 355-367, plts. i-v.

**Hunter, W. D.**—A Tentative Law relating to the Incubation of the eggs of *Margaropus annulatus*. Journ. Econ. Entom., 1908, vol. i, pp. 51-55.

**Leonardi, G.**—Notizie sopra alcune cocciniglie dell' Isola di Giava raccolte dell Prof. O. Penzig. Boll. Lab. Zool., R. Scuola Sup. d'Agric. Portici, 1907, vol. i, pp. 97-116, 38 text figs.

**Leonardi, G.**—Notizie sopra una cocciniglia degli agrumi nuova per l'Italia (*Aonidiella aurantii,* Mask.). Ibid., pp. 117-134, 20 text figs.

**Leonardi, G.**—Contribuzione alla conoscenza delle cocciniglie italiane. Ibid., pp. 135-169, 61 text figs.

**Martelli, G.**—Contribuzione alla biologia della *Pieris brassicae,* L., e di alcuni suoi parassiti ed iperparassiti. Ibid., pp. 170-224, 12 text figs.

**Martelli, G.**—Di alcuni parassiti dell' *Ocnogyna baeticum,* Ramb., osservati nei dintorni di Catanzaro. Ibid., pp. 225-230.

**Masi, L.**—Contribuzioni alla conoscenza sei Calcididi·italiani. Ibid., pp. 231-295, 47 text figs.

**Masi, L.**—Contribuzioni alla conoscenza degli insetti Dannosi all' Olivio e di quelli che con essi hanno rapporto. Ibid., 1908, vol. ii, pp. 185-194, 6 text figs.

**Mokrzecki, S.**—Naturgeschichte einer Halmeule (*Tapinostola maculosa,* Hb.). Zeit. f. wiss. Insekten., 1907, Bd. iii, pp. 87-92, 6 fign.

**Newell, W.**—Notes on the Habits of the Argentine or "New Orleans" Ant, *Iridomyrmex humilis,* Mayr. Journ. Econ. Entom., 1908, vol. i, pp. 21-34.

**Ransome, B. H.**—Notes on Parasitic Nematodes, including descriptions of new Genera and Species, and observations on life-histories. U.S. Dept. Agric., Bur. of An. Indus., Circ. 116, 1907, pp. 1-7.

The new species are *Trichostrongylus capricola, Ostertagia* (n. gen.) *trifurcata, marshalli,* and *occidentalis, Cooperia* (n. gen.) *pectinata,* and *Nematodirus* (n. gen.), the *Strongylus fillicollis* of Rudolphi being the type.

**Schreiner, J. T.**—Zwei neue interessante Parasiten der Apfelmade *Carpocapsa pomonella,* L. Zeit. f. wiss. Insekten, 1907, Bd. iii, pp. 217-220, 1 fig.

**Scott, Hugh.**—On a large series of *Nycteribiidae,* parasitic Diptera, from Ceylon. Trans. Entom. Soc. Lond., 1907, pp. 421-428.

**Silvestri, F.**—Descrizione di un novo genere d'insetti apterigoti rappresentante di un novo ordine. Boll. Lab. Zool., R. Scuola Sup. d'Agric. Portici, 1907. vol. i, pp. 286-311, 18 text figs.

**Silvestri, F.**—Descrizione e prime notizie biologische dell' Ecofillembio dell' Olivio (*Oecophyllembius neglectus,* Silv.). Ibid., 1908, vol. ii, pp. 195-216, 23 text figs.

**Smith, J. B.**—Cultivation and Susceptibility to Insect Attack. Journ. Econ. Entom., 1908, vol. i, pp. 15-17.

**Williamson, E. B.**—The Dragonflies (Odonata) of Burma and Lower Siam—II. Sub-families *Cordulegasterinae, Chlorogomphinae,* and *Gomphinae.* Proc. U.S. Nat. Mus., 1907, vol. xxii, pp. 267-317, 39 text figs.

## IV.—Agriculture and Horticulture.

**Bedford, The Duke of, and Pickering, S. U.**—Eighth Report of the Woburn Experimental Fruit Farm. Pp. iv + 129 and three appendices. London: The Amalgamated Press, Ltd., 1908. Price 2s. 6d.

The work here detailed is of great interest and value, but it is most unfortunate that the authors should write as if they were the only experimenters with insecticides and fungicides; that they were always right and everyone else always wrong. Indeed one would imagine, did one not know otherwise, that His Grace the Duke of Bedford and Mr. Pickering alone were the only people who were permitted to investigate such matters.

Whilst most of the experiments are interesting, many of the results are scarcely practicable, and a few are practically useless. The "if's" and "buts" are very numerous, and, as we have had occasion to previously remark with reference to earlier Reports, this badly wants editing.

L. G.

**Cathcart, C. S.**—Analyses of Paris Green. New Jersey Agric. Exp. Stat., Bull. 205, 1907, pp. 1-9.

**Chittenden, F. H.**—An Injurious North American species of *Apion,* with notes on related forms. U.S. Dept. Agric., Bur. of Entom., Bull. No. 64, pt. iv, 1908, pp. 29-32, fig. 7.

**Evans, J. B. P.**—Peach Leaf Curl. *Exoascus deformans,* Fckl. Transv. Agric. Journ., 1908, vol. vi, pp. 259, 260, 2 plts.

…Factors in the Natural Control of the Mexican …Weevil. U.S. Dept. Agric., Bur. of Entom., Bull. …, pp. 1-79, plts. i-iv, and 2 figs.
…cusses the influence of temperature and moisture, …and of heat, ants, and parasites.

…The Scale Insects of Citrus Trees. Transv. Agric. …, vol. vi, pp. 265-277, plts. 22, 23, 2 text figs.

… and **Chittenden, F. H.**—The Catalpa Sphinx. (*Cera-…lpae*, Bdv.). U.S. Dept. Agric., Bur. of Entom., Circ. …1907, pp. 1-7, 2 figs.

…. and **Chittenden, F. H.**—The Bagworm. (*Thyridopteryx …formis*, Haw.). U.S. Dept. Agric., Bur. of Entom., …o. 97, 1908, pp. 1-10, 11 figs.

…H.—The Relation of Birds to the Cotton Boll Weevil. U.S. …Agric., Biol. Sur., Bull. No. 29, 1907, pp. 1-31, 1 plt., and … figs.

…W. D., **Newell, W., and Pierce, W. D.**—The Insect Enemies …the Boll Weevil. State Crop Pest Comms. of Louisiana, Circ. …. 20, 1907, pp. 1-7, 3 figs.

…V. L.—The Mallophagan Parasites of the Kea. Psyche, 1907, vol. xiv, pp. 122, 123.

…D. E.—An Economic Study of Field Mice (Genus *Microtus*). U.S. Dept. Agric., Biol. Surv., Bull. No. 31, pp. 1-64, plts. i-viii, 3 figs.

…oy, **H. M.**—Practical Remedies for Insect Pests. Agric. Journ. India, 1907, vol. ii. pp. 356-363.

…roy, **H. M.**—The Tse-Tse Fly in India. Ibid., pp. 374-376.

…rlatt, **C. L.**—The White Ant. (*Termes flavipes*, Koll.). U.S. Dept. Agric., Bur. of Entom., Circ. No. 50. rev. ed. 1908, pp. 1-8, 4 figs.

…ierce, **W. D.**—Studies of Parasites of the Cotton Boll Weevil. U.S. Dept. Agric., Bur. of Entom., Bull. No. 73, 1908, pp. 1-63, plts. i-iii, and 6 figs.

**Quaintance, A. L.**—The Lesser Apple Worm (*Enarmonia prunivora*, Walsh). U.S. Dept. Agric., Bur. of Entom., Bull. No. 68, pt.v, 1908, pp. 49-60, plt. vii, 1 text fig.

**Quayle, H. J.**—Insects Injurious to the Vine in California. Calif. Univ. Agric. Exp. Stat., 1907, Bull. No. 192, pp. 99-140, 24 text figs.

**Reh, L.**—Insektenfrass au Kakao-Bohnen. Zeit. f. wiss. Insekten., 1907, Bd. iii, pp. 21-25.

**Shear, Ch.**—Cranberry Diseases. U.S. Dept. Agric., Bur. of Plant Indus., Bull. No. 110, 1907, pp. 1-64, plts. i-vii.

The four chief fungus diseases here described in great detail are scald caused by *Guignardia vaccinii;* rot caused by *Acanthorhynchus vaccinii;* anthracnose, caused by *Glomerella rufomaculans vaccinii;* and hypertrophy, due to *Exobasidium oxycocci.*

The first three mentioned diseases have heretofore been confused and considered as one.

Short notes are given on numerous other less important fungi attacking the fruit, stems, and leaves of the cranberry.

**Voorhees, E. B., and Others.**—Some Chemical and Bacteriological Effects of Liming. New Jersey Agric. Exp. Stat., Bull. 210, 1907, pp. 1-79.

**Voorhees, E. B., and Lipman, J. G.**—A Review of Investigations in Soil Bacteriology. U.S. Dept. Agric., Off. Exp. Stat., Bull. 194, 1907, pp. 1-108.

## V.—Forestry.

## VI.—Fisheries.

## VII.—Medicine.

**Blanchard, R.**—Zoology and Medicine. Ann. Rpt. Smiths. Inst. for 1906. Washington: 1907, pp. 439-452.

**Hamer, W. H.**—Report by the Medical Officer presenting a report by Dr. Hamer, Medical Officer (General Purposes), on the extent to which the fly nuisance is produced in London by accumulations of offensive matter. 10 pp., 2 figs., and 3 diagrams. Printed for the London County Council (Public Health Committee). London: P. S. King and Son, 1908. Price 3d.

Dr. Hamer has set an excellent example to his fellow medical officers in the report before us. In this country local authorities will not take action unless they are confronted with indisputable evidence as to the presence and cause of a nuisance, and the production of such a report as this will have more influence than any number of conclusions which one may deduce from the study of the bionomics of flies.

In spite of the fact that 1907 was a bad year for flies, Dr. Hamer clearly shows that the fly nuisance is aggravated by the presence of accumulations of horse manure and of other refuse, and that the influence of such deposits may be appreciable at a distance of over two hundred yards; at a less distance it is very manifest. The lesson to be deduced from this is clear—refuse should not be deposited after collection in the proximity of houses not even for a short time, the disposal of the refuse

should be direct from the collecting cart to the railway truck or canal barge which takes it away.

In discussing the relation of flies to summer diarrhoea and enteric fever, Dr. Hamer comes to the conclusion that in this country the facts at present ascertained do not enable us to form a definite opinion. The conclusion indicates the path of investigation which we should wish those medical officers of health with the facilities to follow. Statistics and curves are interesting, but the actual investigation of individual cases is much more important. How much evidence of the greatest importance could be adduced if certain cases were carefully studied by discovering the nidus of the flies, careful bacteriological examination of their feet and of isolated faeces such as one finds in unsanitary quarters; if these and other factors were taken into consideration, the results which would accrue would well repay the inevitable labour which accompanies such investigations.

We would recommend this report to all interested in the fly question, and hope similar investigations will be taken up by other medical officers, not only concerning the actual sources of attraction for flies, but also a study of their breeding places, as the results of such investigations would make it difficult for apathetic local authorities to refuse to take the necessary steps to remedy the evil.

C. GORDON HEWITT.

### VIII.—ANIMAL DISEASES.

**Carpenter, Geo. H., and Steen, John W.**—The Warble-Fly. Experiments on Cattle as to its treatment and life history. Journ. Dept. of Agric. Ireland, 1908, vol. viii, pp. 227-246, 3 figs.

This is a most interesting paper, and details a very careful inquiry, although the practical outcome leaves us pretty much in the same position. The authors conclude " that farmers and stock-owners should concentrate their energies on destroying the maggots while they are in the warbles on the beast's backs during the winter and spring," either by squeezing out the maggots, or by applying some poisonous or greasy substance to the warble-hole.

**Hooker, W. A.**—A Review of the present knowledge of the Role of Ticks in the Transmission of Disease. Journ. Econ. Entom., 1908, vol. i, pp. 65-76.

**Phillips, E. F.**—Wax Moths and American Foul Brood. U.S. Dept. Agric., Bur. of Entom., Bull. No. 75, pt. ii, 1907, pp. 19-22, plts. i-iii.

The author shows that two wax moths, *Galleria mellonella* and *Achroia grisella*, do not eat the scales formed from the larvae which have

died of American foul brood. It is clear, therefore, that infectious material in a colony dying of this disease remains even after the comb is destroyed.

**Phillips, E. F.**—Bee Diseases: A Problem in Economic Entomology. Journ. Econ. Entom., 1908, vol. i, pp. 102-106.

**Reynolds, M. H., and Beebe, W. L.**—Dissemination of Tuberculosis by the manure of Infected Cattle. Univ. Minn. Agric. Exp. Stat., Vet. Div., Bull. No. 103, 1907, pp. 39-62, 8 figs.

**Theiler, A.**—The Prevention and Eradication of Stock Diseases in South Africa. Transv. Agric. Journ., 1908, vol. vi, pp. 217-233, 1 plt.

THE

# JOURNAL OF ECONOMIC BIOLOGY.

## ON A COLLECTION OF COCCIDAE AND OTHER INSECTS AFFECTING SOME CULTIVATED AND WILD PLANTS IN JAVA AND IN TROPICAL WESTERN AFRICA.

BY

R. NEWSTEAD, M.Sc., A.L.S., etc.,
*The University of Liverpool.*

WITH PLATES III AND IV.

THE insects herein described and catalogued were collected by Dr. W. Busse, Regierungsrat, Kaiserliche Biologische Anstalt fur Land-und Forstwirschaft, Berlin.

The material was placed in my hands in January 1906, and the MSS. and drawings practically completed shortly afterwards; but owing to other pressing matters I was compelled, much to my regret, to lay the work aside and I have only just been able to revise and complete it.

I take this opportunity of tendering to Dr. Busse my most sincere apologies for the long and unavoidable delay, and beg that he will accept my sincere thanks for giving me the opportunity of examining this interesting collection of insects.

### Fam. COCCIDAE.

#### **Aspidiotus destructor,** Signoret.

Ann. Soc. Ent., Fr. (1869), (4), ix, p. 120.

*Habitat.*—On the leaves of the Cocoa-Palm (*Cocos nucifera,* Linn.), Lome, Togo, xi, 05 (No. 3675). On *Calophyllum inophyllum ;* Atakpome, Togo, x, 01 (No. 3673). On Coco-nut leaves, Kpeme, Togo, i, 05 (No. 3676).

Dr. Busse informs me that this insect causes great harm to the coco-nut plantations in Togo, causing the infested leaves to become yellow and dry.

It is generally a destructive species especially so in the West Indies. It occurs also in China, Formosa, India, Laccadive Islands, Bourbon Island, Mauritius, Demerara, and Mexico, and has also been recorded from other parts of Africa.

Palms of various kinds are its favourite food-plants, but it is a general feeder and among a number of plants I may mention, Mango (*Mangifera indica*), Banana, Nutmeg (*Myristica fragrans*), *Celtis occidentalis*, *Terminalia catappa*, etc.

Larvae and adults of two species of *Coccinellidae* of the genus *Chilocorus* were associated with the coccid; the one with a red head, black thorax, and red discoidal patch on the elytra is allied to *C. discoidens*; the other with a red head and thorax and red at the base and apex of the elytra is probably undescribed. These beetles and their larvae had destroyed between 80 and 90 per cent. of the coccids, so that their presence must have been extremely beneficial.

### **Aspidiotus?** sp.

*Habitat*.—On an unknown shrub; Amussukovhe, Togo, 10.ii.04 (No. 3322).

These examples were so badly infested with a pale orange fungus as to render the coccids quite undeterminable. A similar fungus is known to attack two species of *Diaspinae* in Central Africa.

### **Aulacaspis cinnamomi**, n.sp.

Pl. III, figs. 1-3.

Female puparium approximately circular, low convex or flat, thin and often wrinkled; opaque white with a faint tinge of greenish-yellow giving it a somewhat wax-like appearance, but this character is not always evident; pellicles translucent, dusky ochreous, with a median ridge of black forming a distinct median line.

Length, 1.25-2; greatest width, 1.75-2 mm. Male puparium strongly tricarinate, normal.

Adult female (Pl. III, fig. 1) very elongate with the cephalo-thoracic area nearly as broad as long, posterior angles almost right angles, sides almost straight as far as the large thoracic tubercles. Abdominal segments strongly produced. Pygidium (figs. 2, 3) with one short irregular series of 4 dorsal glands, and an isolated pair in the region of the articulation of the abdomen with the pygidium; circumgenital glands in five groups: median group of about 15, upper laterals 16-19, lower laterals 16-17; median lobes widely divergent tips free, edges and tips serrated; second and third lobes duplex,

outer lateral edges faintly serrated, the lower lobule of the third pair is sometimes divided at the lower margin; the six bilateral squames are simple; the marginal pores are seven in number, the subcutaneous tubes of which become shorter as they approach the first free abdominal segment.

*Habitat.*—On *Cinnamomum ceylanicum* (seedling plants); Molioardjo, East Java, 7.i.03 (No. 1784). Also on an unknown shrub in the forest near Smeroe (Casuarinen Region); about 1,800 m. (No. 1788).

### **Aulacaspis javanensis**, n.sp.

Pl. III, figs. 4-6.

Female puparium approximately circular, flat or low convex, smooth and wax-like and somewhat opaque; larval exuviae marginal, pale fulvus.

Length, 1.50-2 mm; greatest width, 1.50-2 mm. Male puparium white and strongly tricarinate.

Adult female (fig. 4) very elongate, highly chitinised; cephalothorax nearly as broad as long, posterior angles broadly rounded (in well restored specimens), free abdominal segments broad and strongly produced at the sides. Pygidium (Pl. III, figs. 5, 6) with *three continuous series of dorsal glands*, the second and third series extending into the succeeding segment of the abdomen; circumgenital glands in five almost continuous groups, the anterior group of 15-16, the anterior laterals from 18-22; median lobes widely divergent, apices free, inner margin curved outwards and finely serrated; second and third lobes duplex, small; third pair often obscured by the thickened apex of a projecting marginal pore; squames 7-8 in number, simple, and there are 4-5 on the adjacent segment; marginal pores 8-9, a few small ones also occur on the rudimentary and two succeeding segments of the abdomen.

*Habitat.*—On Ericacea (?) and two undermentioned shrubs. Forest on the mount Smeroe, East Java, about 1800 m., 7.i.03 (Nos. 1785, 1786), also on an aquifoliaceous shrub. Forest on the Smeroe, 7.i.03 (No. 1789) and in Bamboo-wood on the Smeroe, 14-1500 m., 7.1.03 (No. 1790).

### **Fiorinia diaspiformis**, n.sp.

Pl. III, figs. 7-10.

Female puparium purple brown or smoky brown, margins paler; *secretional margin unusually wide*, often considerably wider than the

length of the nymphal pellicle; pellicles pale yellowish-brown, terminal secretionary covering smoky brown. Form somewhat irregular, usually broadly pyriform, but some examples have a tendency to become more or less circular.[1] Ventral pellicle complete, thin anteriorly, thick posteriorly; colour smoky grey.

Length, 1.75-2.75 mm., width, 1.50-2 mm.

Male puparium white, thickly felted and very strongly tricarinate; pellicle yellowish-brown.

Length, 1 mm.

Adult female oviparous; not highly chitinised; ovate, with the margins of that free abdominal segments strongly defined; cephalo-thoracic area distinctly divided. Rostral filaments[2] two and a half to three times the length of the body.

Rudimentary antennae placed closely together near the anterior margin, each furnished with a single, long curved spine. Para-stigmatic glands arranged in a compact group, anteriorly. Anal orifice immediately below the anterior group of circumgential glands. Pygidium (Pl. III, figs. 7, 8) somewhat produced; median lobes small approximate, margins strongly dentate; lateral lobes small, entire, the first sometimes spatulate; synames large, four on either side, and there are three or four on each of the succeeding abdominal segments; spines minute; the first three or four pairs of marginal pores with more or less angular projections, the rest not so, and they extend into the cephalo-thoracic area. Circumgenital glands in five groups; median with 10-11; upper laterals with 22-28; lower laterals with 16-27. Dorsal pores in three continuous series, the third following the line of the succeeding segment.

Second Stage Female (Pl. III, fig. 9) much more elongate than the adult female. Margin of pygidium (Pl. III, fig. 8) closely resembling that of the adult, but the lateral lobes are either quite rudimentary or entirely absent, and there are only four bilateral marginal pores, forming angular or rounded projections.

The female puparium superficially resembles certain forms of *Aulacaspis* due to the abnormally large supplementary secretion. The other distinguishing feature is the enormously long rostral filaments.

*Habitat.*—On *Piper* sp.; Bamboo-wood on the Smeroe, East Java, about 1,500 mm., 7.i.03 (No. 1787).

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[1] These forms are apparently immature.

[2] These organs become detached almost invariably in the process of removal from the food-plants.

**Chionaspis (Hemichionaspis) aspidistrae**

var. **gossypii**, n. var.

Female puparium. Form resembling typical examples of *C. aspidistrae*, being elongate and widened posteriorly but with little tendency to become curved or mytiliform. Colour pale ochreous; texture rough owing to a scanty, superimposed, layer of red-brown bark fibres being incorporated with the secretionary matter; pellicles darker than the rest of the puparium.

Length, 2-2.50 mm.

The adult females are slightly larger than typical examples found under glass in Europe; but structurally they are practically identical.

The examples submitted for examination almost covered the bark of the small branches, and must therefore have caused some injury to the plant.

*Habitat.*—On *Gossypium hirsutum;* Kpeme, Togo, i.05 (No. 3678).

**Mytilaspis (Lepidosaphes) ?** sp.

*Habitat.*—On *Terminalia catappa*, Buitenzorg, Java; xii.02 (No. 1701).

Three female puparia in association with *Parlatoria proteus* and a species of *Aleurodes*. The material was not sufficient for diagnostic purposes.

**Parlatoria proteus,** Curtis.

Gardener's Chronicle (1843), p. 676.

*Habitat.*—On *Terminalia catappa;* Buitenzorg, Java; xii.02 (No. 1701). This species was found in association with *Aleurodes* sp. and *Mytilaspis* sp. Not hitherto recorded from Java; but this insect is very widely distributed throughout the world.

**Dactylopius coffeae,** n.sp.

Pl. III, figs. 14-16.

Adult female covered with densely felted plates of white secretion, but this covering was so much injured as to render it impossible to give a correct description of its arrangement. Form rather short, ovate. Antenna (Pl. III, figs. 14, 14a.) long, setose, of eight segments, terminal segment much the longest and some of the hairs upon it are longer and stouter than the rest. Legs normal. Margins with an equidistant series of spines (Pl. III, fig. 9) usually in pairs, each surrounded by a group of rather large spinnerets. Dermal spinnerets minute; spines few and scattered. There are two pairs of large

chitinised; slender but small compared with the size of the insect; *coxa almost equalling the length of the femur;* digitules simple. Marginal spines (Pl. IV, fig 4) with their broad bases suddenly contracted each fitting into a well-defined socket, the latter being attached to a short subcutaneous tube. Stigmatic channels and spines absent.

Length, 13-15 mm.; width, 12-13 mm.

Second Stage Female (Pl. IV, fig. 7) broadly ovate, slightly narrowed posteriorly, marginal spines continuous resembling those in the adult. Antennae of seven segments, the third being the longest, the rest of the segments subequal in length. Legs scarcely longer than the antennae; coxa rather broad. Mentum uniarticulate. Groups of spinnerets (Pl. IV, fig. 8) occupying relatively the same position as in the adult, but there are only about 60-70 individual spinnerets in each group; they are also larger and more distinctly separated than in the adult. Derm in the region of the anal cleft finely squamose, with a large subcutaneous tube (Pl. IV, fig. 9); there is also a similar tube just within the margin opposite the anterior stigmata.

Larva (Pl. IV, fig. 10) elongate; position of the compound spinnerets as in the adult and nymph. Mentum monomerous. Antenna (Pl. IV, fig. 11) of six joints, the third equalling the length of the fourth, fifth and sixth together. Marginal spines forming a continuous series.

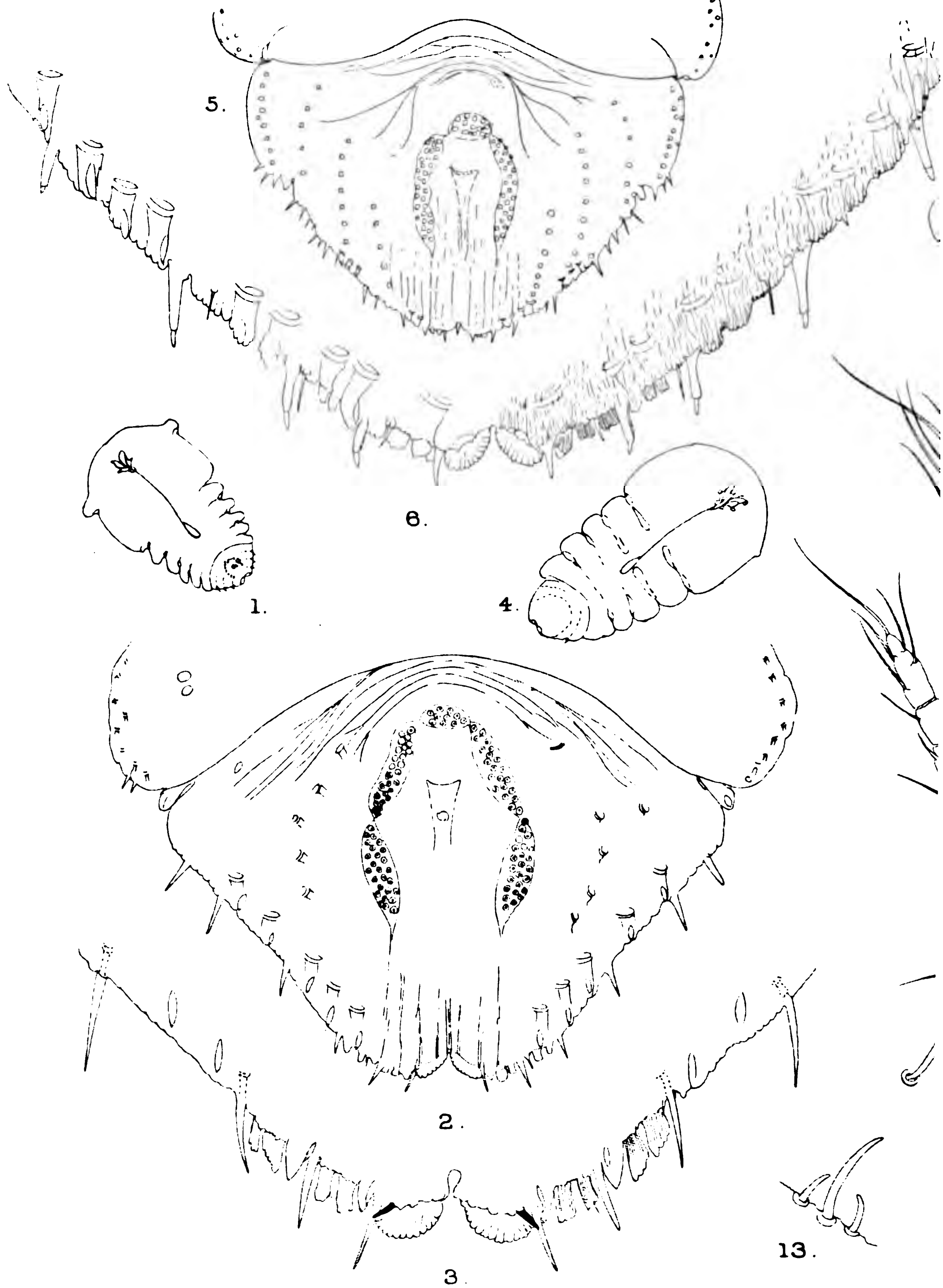
*Habitat.*—On the stems of the Cacao *(Theobroma cacao)*; Soppo, Cameroon, W. Africa, March, 1905 (No. 3677).

This is an extremely interesting and highly protective species, and is also one of the largest members of the *Lecaniinae*; but although so large it is a very inconspicuous insect as the irregular prominences of the dorsum, together with its mealy covering so exactly harmonises with the colour of the bark on which it rests that it is difficult, in many instances, to see where the insect ends and where the bark begins. If I translate Dr. Busse's notes correctly he says "this insect imitates little bosses or excrescences on the bark of the cocoa stems, and so deceptively in shape and colouring that it requires some experience before you can recognise the animals as such."

### **Stictococcus sjöstedti,** Cockerell.

Canadian Ent. (1903), xxxv, p. 64.

*Habitat.*—On the fruit and fruit-stalks of the Cacao; Victoria, Cameroon; ix.04. (Nos. 3169, 3189).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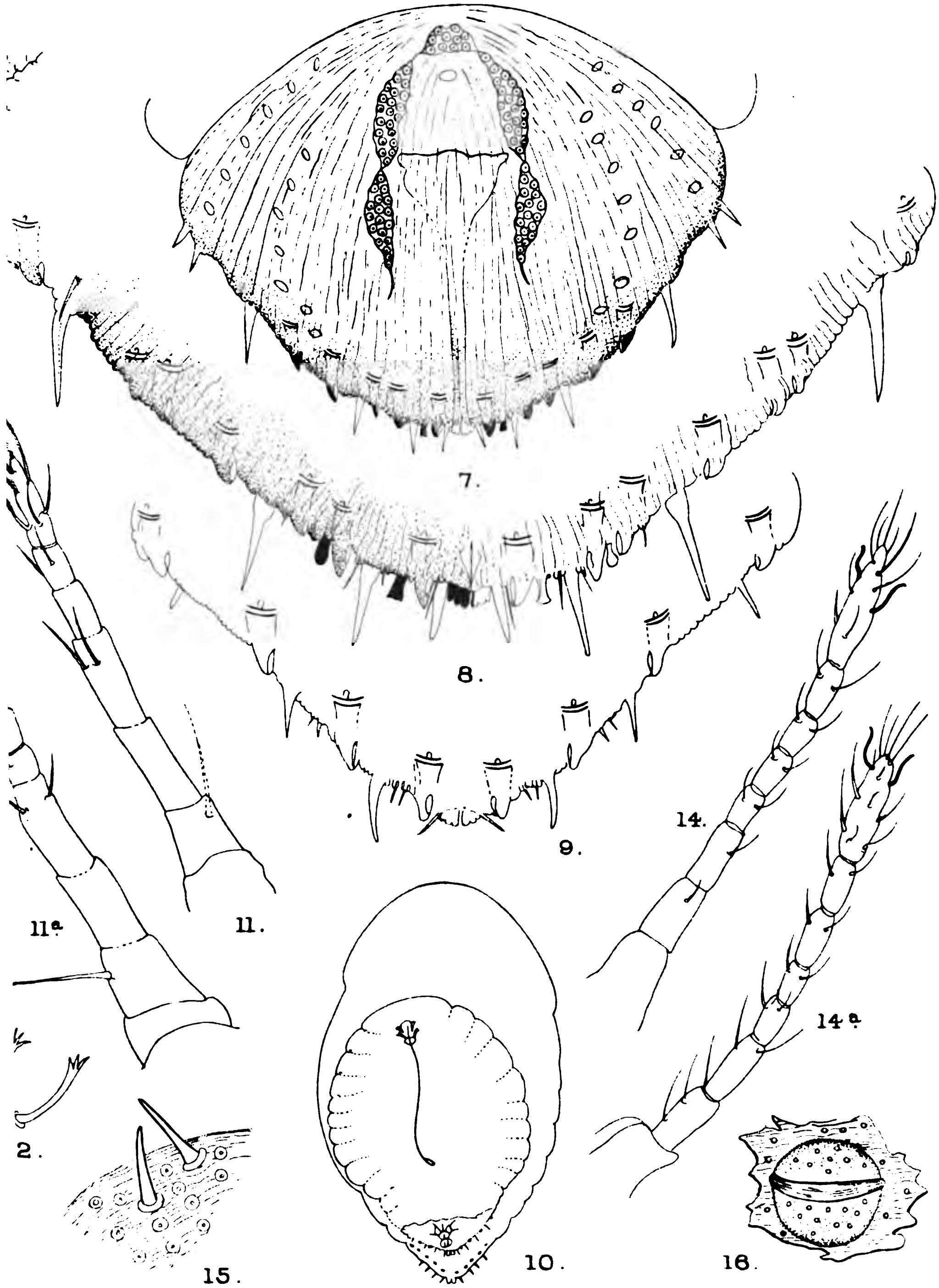


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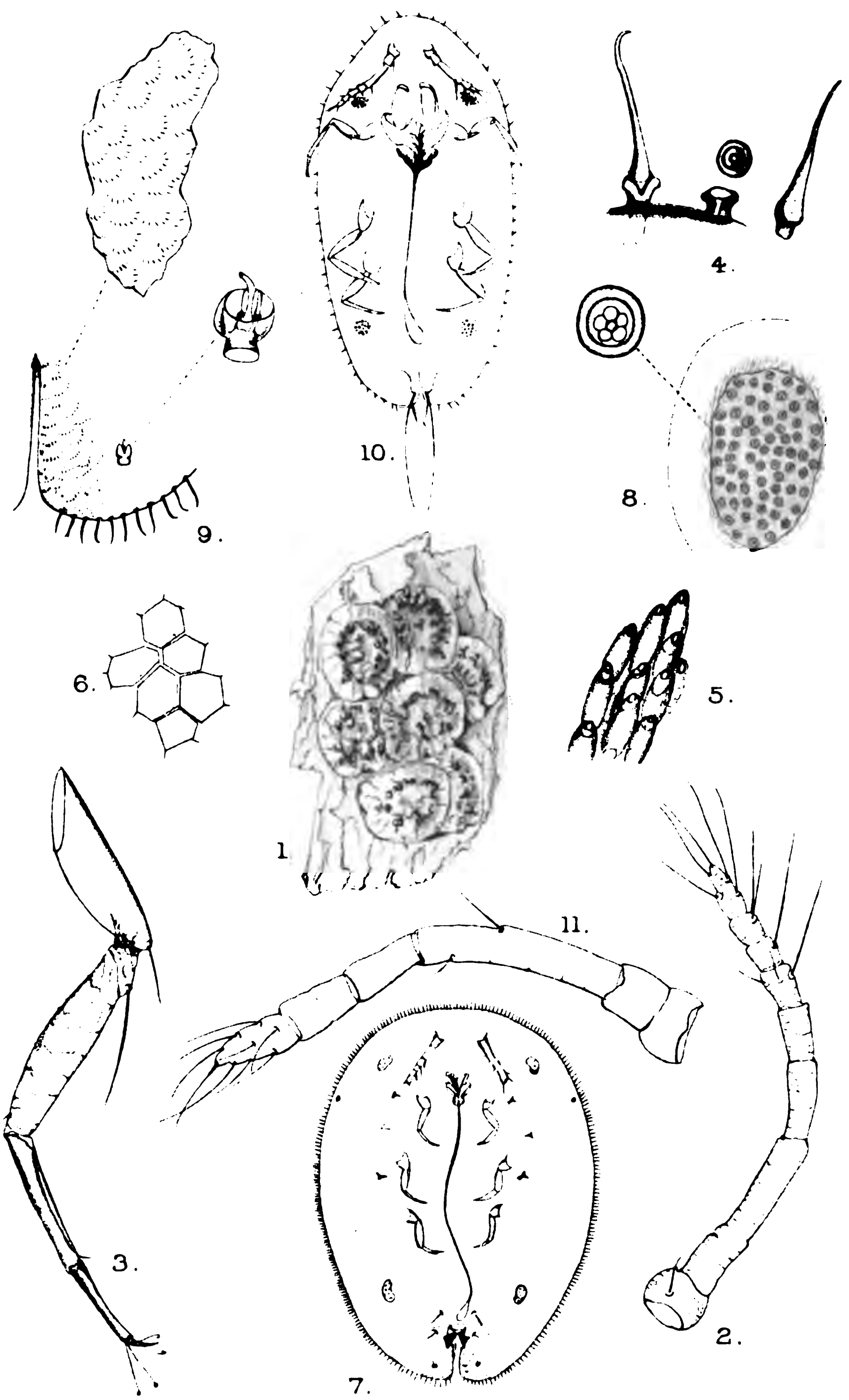


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*HEMILECANIUM THEOBROMÆ* n.g. & n. sp.

Since its discovery by Dr. Sjöstedt in 1903, this insect has been found in several other localities along the West Coast of Africa; but it has not been recorded from any other part of the world. From information recently obtained one gathers that this insect is one of the recognised cocoa pests in Western Africa.

### Fam. ALEURODIDAE.

**Aleurodes ? sp.**

*Habitat.*—Java on *Terminalia catappa;* Buitenzorg, Java, (No. 1701). Associated with *Parlatoria proteus* and the *Mytilaspis.* The leaves were almost covered with this insect, but they were not sufficiently well preserved to enable one to determine them specifically.

### Fam. PSYLLIDAE.

**Psylla, sp.**

*Habitat.*—On *Kickxia elastica;* Soppo, Cameroon (No. 3674).

This insect produces a deep ovate depression on the underside of the leaf with a corresponding raised, tubercular, swelling on the upper surface. They were packed so closely together that the leaves, from the innumerable pits and swellings, presented a most remarkable appearance.

The examples (No. 3674) sent in the first instance consisted of larvae and pupae, and as it was not possible to determine the insect from the material, Dr. Busse very kindly obtained a further supply of the infested leaves. On examining these I was disappointed to find that the few winged forms which were present were all so damaged as to render them quite useless. This insect is of considerable economic importance, so that further endeavours should be made to obtain perfect examples of the adult.

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## EXPLANATION OF PLATES III AND IV.

Illustrating Mr. Robert Newstead's paper on "A Collection of *Coccidae* and other Insects affecting some cultivated and old plants in Java and in tropical Western Africa."

### PLATE III.

**Aulacaspis cinnamomi,** n.sp.

Fig. 1.—Adult female (enlarged).
Fig. 2.—Pygidium of do. × 250.
Fig. 3.—Margin of pygidium. × 600.

**Aulacaspis jarvanensis,** n.sp.

Fig. 4.—Adult female (enlarged).
Fig. 5.—Pygidium of adult female. × 250.
Fig. 6.—Margin of pygidium. × 600.

**Fiorinia diaspiformis,** n.sp.

Fig. 7.—Pygidium of adult female. × 250.
Fig. 8.—Margin of pygidium of adult female. × 600.
Fig. 9. Margin of pygidium of second stage female. × 600.
Fig. 10. Adult lying within the moulted skin of the second stage female (enlarged).

**Lecanium hesperidum** var. **jarvanensis,** n. var.

Fig. 11, 11*a*. Antennae of adult female. × 250.
Fig. 12. Marginal spines of adult female. × 600.
Fig. 13. Stigmatic spines of adult female. × 250.

**Dactylopius coffeae,** n.sp.

Fig. 14, 14a.—Antennae of adult female. × 250.
Fig. 15.—Portion of epidermis (with glands and spines) of adult female. × 600.
Fig. 16.—One of the large glandular orifices of adult female. × 120.

PLATE IV.

**Hemilecanium theobromae,** n.sp.

Fig. 1.—Group of adult females (natural size).
Fig. 2.—Antennae of adult female (enlarged).
Fig. 3.—Leg of adult female (enlarged).
Fig. 4.—Marginal spines of adult female. × 250.
Fig. 5.—Derm cells of the dark central area of dorsum. × 350.
Fig. 6.—Derm cells of the marginal area. × 250.
Fig. 7.—Second stage female (enlarged).
Fig. 8.—Group of compound spinnerets. × 130, about.
Fig. 9.—Right portion of the anal extremity of the nymph showing the squamose character of the dermis, and the curious secretionary gland (× 600).
Fig. 10.—Larva (enlarged).
Fig. 11.—Antennae of the larva. × 250.

# ON AN ENCHYTRAEID WORM INJURIOUS TO THE SEEDLINGS OF THE LARCH.*

By

C. GORDON HEWITT, M.Sc.,

*Lecturer on Economic Zoology in the University of Manchester.*

WITH PLATE V.

WHEN the seedlings of the larch attain the age of about 12-14 months they are frequently attacked by a small white worm, and the presence of such a pest in a nursery is readily discernable by the dead and withered appearance of the plants.

I find on inquiry that the killing off of the seedlings is attributed by foresters and nurserymen to the presence of "a worm," but the character of the worm when it is specified is usually incorrect, some calling it a "wire-worm" and others an "eel-worm." Last year I was able to examine some larch-seedlings in nurseries at Thirlmere (Cumberland) and found that the worm which was responsible for the damage was neither a wire-worm nor an eel-worm, but differed from each of these by as much as they differ from each other. It proved to be a small white Oligochaet worm, belonging to the family *Enchytraeidae*, and Mr. F. E. Beddard very kindly identified it for me as *Fridericia bisetosa*, Levinsen.

The *Enchytraeidae* form a compact and easily separable family of the Oligochaet worms, which is of course of economic interest on account of the phytophagous habits of some of its members. They not only feed on decaying vegetable matter, but also on living plants, in which cases, as in the present, they sometimes become seriously injurious.

Theobald (1906) records specimens of *Enchytraeia* worms being sent as eel-worms from Hastings, where they occurred in such substances as rotten leaves and road-scrapings, and also in old horse-dung; they were also found in flower beds containing roses and pansies.

The *Enchytraeidae* are small worms ranging, according to Beddard (1895) from 3 mm. to 40 mm. in length. All possess a prostomium.

* Read before the Association of Economic Biologists, Edinburgh Meeting, July 28th, 1908.

[JOURN. ECON. BIOL., 1908, vol. iii, No. 2.]

The members of the germs ***Fridericia***, to which this worm belongs, are chiefly characterised by the possession of dorsal pores: they are also distinguishable in the characters of their setae. Beddard *(t.c.)* states that they are developed in each bundle two at a time, the newly-formed pair lying between the older pair, and the next pair between these, and so on, so that in a group of setae the outermost are the oldest and the innermost are the youngest setae. In this species *F. bisetosa* the older pair usually falls out before the younger ones are formed, so that, as the name implies, the worm has only two setae in each bundle. This, however, is not always the case in *F. bisetosa*, and my observations confirm those of Ude, who found that in immature individuals four setae occur in each group, the older outer pair not having fallen out; I find this to be the case in mature specimens also, and a group of these setae are shown in fig. 3.

*Fridericia bisetosa*, Levinsen, is defined by Beddard as follows :—

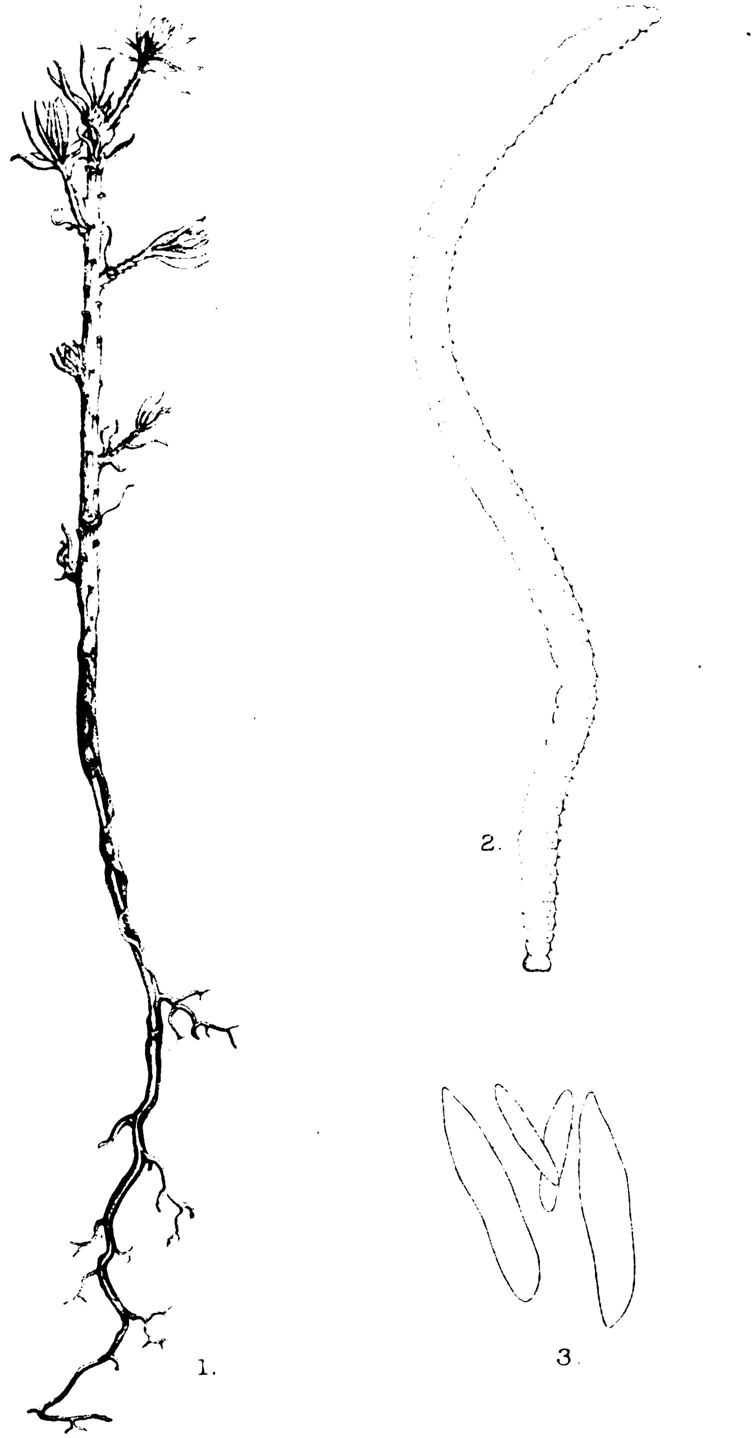
"Length, 20 mm.; number of segments, 60; setae paired; Anteseptal region of nephridium nearly equal to post-septal, with undulating duct. Spermathecae with two diverticula."

The worms are white and at first sight have an appearance rather similar to Nematodes, but on a closer examination their real nature is soon perceived. This species is further characterised anatomically by the fact that the brain is about twice as long as broad, and its posterior border is either straight or slightly concave. The dorsal vessel arises in the 18th segment. The vasa deferentia are long and coiled, and their funnels are twice as long as broad; the spermiducal glands are well developed.

This pest does not appear to attack larches that are more than twelve or fourteen months old. The signs of the attack are a gradual shrivelling up of the whorls of young green leaves, which is followed by a withering of the upper portion of the young seedling as it is gradually killed. If such seedlings are pulled up or, better, carefully dug up, the small white worms, measuring about three-quarters of an inch in length, will be found round the main root and in the earth surrounding it. The injury is done to the root beneath the ground: the cortical tissue is destroyed, as shown in the figure, leaving the central woody cylinder exposed. This radical decortication is fatal to the young plants and they soon die.

Worms of this nature, as Theobald *(l.c.)* has also shown, can be destroyed by means of carbon-bisulphide. On the appearance of this worm in the larch nurseries the method of treating the seedlings which I should suggest would be to inject the carbon-bisulphide by

Journ. Econ. Biology, 1908, Vol. III, pt 2. Pl V.

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FRIDERCIA BISETOSA, Lev.

means of a Vermorel or other suitable injector. The injections should alternate on the two sides of each row of seedlings, each injection being about six or eight inches from the row, and stoping obliquely towards the row. So that the volatilising carbon-bisulphide may rise to the roots. The injection must be made deep enough to prevent the liquid touching the roots of the seedlings, and the injections of each side of the row should be about two feet apart. The carbon-bisulphide should only be injected when the soil is dry, otherwise it will not be able to reach the worms at the roots of the seedlings when it volatilises. From a quarter of an ounce to half an ounce, or nine to eighteen grammes, will be sufficient for each injection.

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1906. **Theobald, F. V.**—" Report on Economic Zoology for the year ending April 1st, 1906." *Journal of the South-Eastern Agricultural College, Wye, Kent.* pp. 29-140.

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## EXPLANATION OF PLATE V.

Illustrating Mr. C. Gordon Hewitt's paper "On an Enchytraeid Worm injurious to the Seedlings of the Larch."

Fig. 1.—Larch seedling, twelve months old, showing the appearance of the root and shoot of a seedling killed by *F. bisetosa.*

Fig. 2.—*Fridericia bisetosa,* Levinsen.

Fig. 3.—Single Group of setae of *F. bisetosa,* showing the outer and older setae remaining after the appearance of the inner younger setae.

# A NOTE ON THE FLIGHT OF THE EARWIG, FORFICULA AURICULARIA, LINN.

By

WALTER E. COLLINGE, M.Sc., F.L.S.,

*Berkhamsted.*

THE wings of earwigs have long been a subject of interest amongst zoologists, both on account of their actual structure, and also the complex manner in which they fold them up when in repose.

Almost every writer on the *Forficulidae* has drawn attention to the fact that a large number of species of the family have the wings undeveloped, or they are folded in a complex manner, similar to the species under consideration.

In spite of the complexity of the wings in the common earwig, it is generally supposed that they are seldom used. Dr. Sharp[1] writes: "It is quite a mystery why earwigs should fold their wings in this complex manner, and it is still more remarkable that the Insects very rarely use them. Indeed, though *Forficula auricularia* is scarcely surpassed in numbers by any British Insect, yet it is rarely seen on the wing; it is probable that the majority of the individuals of this species may never make use of their organs of flight or go through the complex process of unfolding and folding them."

During the latter part of June and early in July I heard numerous complaints of the enormous number of these insects, which were committing serious damage to garden plants and invading houses in large numbers.

Quite unaware of the rarity of the occasion, a friend remarked to me that they had frequently flown through the open window in an evening, and when I remarked that they were seldom known to fly, he advised me to throw open my window between 9 and 10 p.m.

For three consecutive evenings I opened two casement windows between 9.30 and 10.30, with the following result:—On the first evening eight earwigs entered the room in flight, on the second evening eleven, and on the third evening seven.

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[1] Insects, Camb. Nat. Hist., 1901, vol. i, p. 207.

[JOURN. ECON. BIOL., 1908, vol. iii, No. 2.]

In nearly all cases they came through the window and flew to the right or left of the room, evidently to avoid the gas, but on two occasions they passed over the gas and settled on the picture moulding opposite to the window.

An examination of the 26 specimens revealed the significant fact that they were all males.

If within the space of one hour an average of 9 insects flew into my room, it seems only reasonable to suppose that there were many more on the wing out of doors.

I am aware that they have previously been recorded in flight,[1] but I think there must be certain conditions that are conducive to this habit.

The three evenings I mention were very warm, calm, sultry ones, and fairly dark. In any case the phenomenon is sufficiently rare to be worthy of placing on record.

Since the above was written a case has come under my observation of where in the open daylight a specimen flew in at the window of an office, settled on an open book, and the process of folding the wings was carefully noted by the observer; also a further case where one was knocked off a person's coat, and instead of falling to the ground immediately took to flight.

[1] See Theobald, Entom. Mon. Mag., 1896, vol. vii (2nd Ser.), p. 60.

## REVIEWS AND CURRENT LITERATURE.

### I.—General Subject.

**Burgess, A. F.**—Uniform Common Names for Insects. Journ. Econ. Entom., 1908, vol. i, pp. 209-213.

A very useful list, but we do wish that American Economic Entomologists would not use the term "worm" for larva or caterpillar.

**De Vries, Hugo.**—Plant Breeding. Comments on the Experiments of Nilsson & Burbank. Pp. xv + 360, 114 figs. London: Kegan Paul, Trench, Trübner & Co., Ltd 1907. Price 7s. 6d.

In the author's words the main aim of these Essays is to give proof of the assertion that "Hybridization is the scientific and arbitrary combination of definite characters. It does not produce new unit-characters; it is only the combination of such that are new. This far-reaching agreement between science and practice is to become a basis for further development of practical breeding as well as of the doctrine of evolution."

The appreciation of such investigations as are here set forth must soon change the whole aspect of agricultural plant breeding, and consequently such a work as that before us is full of interest to the practical breeder as well as the student of plant evolution.

All who have studied the work of De Vries know how such has materially modified our views as to the origin, selection and adaptation of species, and these facts are in these essays brought home to one with a force that compels recognition.

After a brief introductory chapter on Evolution and Mutation, the author discusses in detail the work of Hjalmar Nilsson and that of Luther Burbank, sandwiching in between these a most lucid and fascinating chapter on Corn Breeding. In the two concluding chapters the association of characters in plant-breeding is fully discussed, and more briefly, the geographical distribution of plants.

Corn breeding, we are informed, is a new industry, hardly older than ten years, but it has developed at once on a commercial scale. Experience

proves it to be highly profitable, and the conviction is rapidly spreading that no corn grower can afford to be ignorant of its principles and its results.

We heartily commend the book to all who take an intelligent interest in plant breeding.

W. E. C.

**Forel, Auguste.**—The Senses of Insects. Translated by Macleod Yearsley. Pp. xv + 324, plts. 1, 2. London: Methuen and Co., 1908. Price, 10s. 6d.

Biologists, and entomologists in particular, are under a debt of gratitude to Mr. Macleod Yearsley for the English translation of Dr. Forel's fascinating work. As he justly remarks the work is but little known in this country, is full of interesting experimental details, and exhibits such a wide field of painstaking investigation that it only requires translation to find a considerable number of readers in this country.

So much that is worthless has been written upon the senses of insects, or perhaps we should say the supposed senses, that one turns to the present work with a feeling of relief and with a knowledge that the subject is being dealt with by a masterly mind and in a logical, fair, and open-minded manner.

It is not our intention to attempt any detailed criticism, but we cannot refrain from stating that a careful perusal of this book has only whetted our appetite for more such observations, and at the same time afforded a pleasure not realized since we read Semper's "Animal Life" and Lubbock's "Senses, Instincts, etc., of Animals."

It is a book to read and think over, and to all who have the slightest interest in the ways of insects our advice is "get it at once."

W. E. C.

**Gamble, F. W.**—Animal Life. Pp. xviii + 305 and 62 figs. London: Smith, Elder and Co., 1908. Price 6s. net.

There has recently been published quite a number of delightfully written works on animal life, unfortunately, however, the value of many of these is considerably mitigated by the many misstatements of fact, inaccurate observation and careless compilation. Dr. Gamble's book differs from such works in that it is most carefully compiled, full references being given to authorities, and free from the other blemishes just referred to.

Throughout the three hundred pages there is exhibited a freshness and lucidity of expression that cannot fail to impress the reader and excite his interest.

It is a book that all interested in animal life may read with pleasure and

profit, and it might with advantage find a place in every college and school library.

The weakest point of the work, if it has one, is the illustrations, which are unworthy of the text.

W. E. C.

**Hinds, W. E. and Bishopp, F. C.**—A Key suggested for the Classification of Entomological Records. Journ. Econ. Entom., 1908, vol. i, pp. 91-102.

**Isaac, J.**—Entomology in Outline. 2nd Rpt. Comms. Hort. Calif. for 1905-6, 1907, pp. 35-154, 1 plt. and 111 text figs.

This excellent introduction to entomology has been written in the simplest manner, in plain, everyday language, divested so far as possible of all scientific and technical terms. It is intended for the horticultural commissioners, fruit-growers, and farmers, and is in no sense offered as a scientific dissertation on entomology.

The author has fulfilled a by no means easy task in an admirable manner, which cannot fail to be fully appreciated by those for whom it is intended.

W. E. C.

**Knuth, P.**—Handbook of Flower Pollination. Translated by J. R. Ainsworth Davis, vol. ii, pp. viii + 703, and 210 text figs. and 1 portrait. Oxford: The Clarendon Press, 1908. Price 32s. 6d. net.

We extend a hearty welcome to the second volume of this most interesting and valuable work. It is a veritable mine of information of interest alike to the botanist and entomologist, while it bristles with points of general biological interest.

The present volume deals with fifty-six natural orders.

The information given is concise but sufficiently full when read in conjunction with vol. i.

The whole subject of flower pollination is one of such immensity and so closely allied to other equally fascinating biological phenomena, that we dare not attempt any lengthy review, even did space permit or were we capable of such, for a work of this character speaks for itself, and must find a place and a welcome wherever biological problems are studied or taught.

W. E. C.

**Massee, G. & Theobald, F. V.**—The Enemies of the Rose. Pp. 84, 8 col. plts. and 5 figs. National Rose Society. [1908].

This little handbook is conveniently divided into two parts, viz., one, written by Mr. Massee, treating of the Diseases caused by Fungi, and another on Insect Enemies for which Mr. Theobald is responsible.

In 18 pages Mr. Massee has given a valuable and admirably condensed account of the different fungi attacking the rose, together with the preventive and remedial treatment. The description is well illustrated by four coloured plates showing the appearance of different diseases.

Mr. Theobald's account of the insect enemies of the rose is just as prolix as Mr. Massee's is brief, whilst many of the insects enumerated are scarcely what the rose grower regards as enemies, for the simple reason that he seldom, if ever, is troubled with them.

The remedies suggested are not always the happiest. The writer has more than once ruined beautiful plants by using quassia for greenfly, and has also seen great mischief wrought by the use of arsenate of lead on roses.

Such remedies are behind the times and belong to a day when rule of thumb culture obtained, happily they are now things of the past to the intelligent and up-to-date rose grower.

The "General Account of Insects" might have been omitted with advantage, whilst some reference to the authorities from whom Mr. Theobald has collated his facts would have been valuable.

L. G.

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**Effenberger, W.**—Die Tracheen bei *Polydesmus*. Zool. Anz., 1897, Bd. xxxi, pp. 782-786, 4 figg.

**Enderlein, G.**—Über die Segmental-Apotome der Insekten und zur Kenntnis der Morphologie der Japygiden. Ibid., pp. 629-635, 8 figg.

**Haller, B.**—Über die Ocellen von *Periplaneta orientalis*. Ibid., pp. 255-262, 4 figg.

**Hirschler, J.**—Über leberartige Mitteldarmdrüsen und ihre embryonale Entwicklung bei *Donacia*. Ibid., pp. 766-770, 4 figg.

**Holmgren, N.**—Zur Morphologie das Insektenkopfes. Ibid., Bd. xxxii, pp. 73-97. 11 figg.

**Imms, A. D.**—Notes on the Structure and Behaviour of the Larva of *Anophles maculipennis*, Meigen. Proc. Camb. Phil. Soc., 1907, vol. xiv, pp. 292-295.

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**Wassilieff, A.**—Die Spermatogense von *Blatta germanica*. Arch. mikr. Anat., 1907, Bd. lxx, pp. 1-42, T. i-iii, 1 fig.

**Zavrel, J.**—Die Augen der Dipterenlarven und-Puppen. Zool. Anz., 1907, Bd. xxxi, pp. 247-255, 13 figg.

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III.—General and Systematic Biology, and Geographical Distribution.

**Banks, N.**—A Revision of the Ixodoidea, or Ticks of the United States. U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No. 15, 1908, pp. 1-61, plts. i-x.

A valuable paper to students of the Ixodoidea generally. The author records 38 species and 3 unplaced forms.

**Bayer, É.**—Notes sur les Galles de *Dryophanta agama* et *disticha* de l' iconographie "Galles de Cynipides." Marcellia, 1908, vol. vii, pp. 3-9, figs. 1-6.

**Bezzi, M.**—Noterelle cecidologiche. Marcellia, 1908, vol. vii, pp. 10-13.

**Brues, C. T.**—The Correlation between habits and structural characters among parasitic Hymenoptera. Journ. Econ. Entom., 1908, vol. i, pp. 123-128.

**Brunetti, E.**—Revision of the Oriental *Stratiomyidae*. Rec. Indian Mus., 1907, vol. i, part 11, pp. 85-132.

A useful paper including tables of genera and species, and also descriptions of several new forms.

**Brunetti, E.**—Notes on Oriental Diptera. Nos. I and II. Ibid., pp. 163-170,

The first part of these notes comprises a list of the oriental species of the important economic group *Diopsinae*. Altogether 12 specie of *Diopsis*, 9 of *Teleopsis* and 2 *Sphyracephala* are enumerated. Part II. is a preliminary report on a collection of about 130 species of Diptera obtained between April 24th and May 8th, 1907, in the Simla district, at altitudes varying from 5,000 to 8,700 ft. The collection exhibits a marked Palaearctic facies, and considerable proportion of European species, these latter, moreover, retaining for the most part their typical form.

A. D. Imms.

**Carnes, E. K.**—The *Coccidae* of California. 2nd Rpt. Comms. Hort. Calif. for 1905-6, 1907, pp. 155-222, plts. ii-v, 34 text figs.

A very useful and interesting paper enumerating 132 species.

**Caudell, A. N.**—Notes on some Western Orthoptera; with the description of one New Species. Proc. U.S. Nat. Mus., 1908, vol. xxxiv, pp. 71-81.

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**Franklin, H. J.**—On a collection of Thysanopterous Insects from Barbadoes and St. Vincent Islands. Proc. U.S. Nat. Mus., 1908, vol. xxxiii, pp. 715-730, plts. lxiii-lxv.

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**Headlee, T. J.**—Life History of the Striped Cucumber Beetle, with a brief account of some experiments for its control. Journ. Econ. Entom., 1908, vol. i, pp. 203-209.

**Houghton, C. O.**—Notes on *Trogoderma tarsale*, Marsh. Journ. Econ. Entom., 1908, vol. 1, pp. 216-217.

**Jordan, K. and Rothschild, N. C.**—Revision of the Non-combed eyed Siphonaptera. Parasitology, 1908, vol. i, pp. 1-100, plts. i-vii.

**Marlatt, C. L.**—The National Collection of *Coccidae*. U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No. 16, Pt. 1., 1908, pp. 1-10.

**Martelli, G.**—Note dietologiche sulla mosca delle olive. Boll. Lab. Zool. gen. e agrar. Portici, 1908, vol. ii, pp. 1-12.

**Martelli, G.**—Osservazioni sulle Cocciniglie dell' olivo fatte in Puglia e in Calabria. Ibid., pp. 217-296, 22 figs.

**Masi, L.**—Sul numero e sulla denominazione dei parassiti della mosca delle olive. Ibid., pp. 185-194, 1 fig.

**Niessen, J.**—*Aphis cardui*, L. auf *Oenothera muricata*, L. Marcellia, 1908, vol. vii, p. 14, 2 figs.

**Paiva, C. A.**—Records of Hemiptera and Hymenoptera from the Himalayas. Rec. Indian Mus., 1907, vol. i, part i, pp. 13-20.

Comprises a number of species collected during 1905 and 1906 by four or five collectors in various parts of the Himalayas. Exact localities and

approximate altitudes are given, and the list is of importance to students of distribution, dealing as it does with localities up to 11,000 ft.

**Pierce, W. D.**—Descriptions of new Curculionid Beetles of the Tribe *Anthonomini*. Proc. U.S. Nat. Mus., 1908, vol. xxxiv, pp. 173-181.

**Quayle, H. J.**—The California Life History of the Grape Leaf-Hopper, *Typhlocyba comes*, Say. Ibid., pp. 182-183, plts., i, ii.

**Rübsaamen, E. H.**—Beiträge zur Kenntnis Aussereuropäischer Zoocecidien. Marcellia, 1908, vol. vii, pp. 15-79, figs. 8-17.

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**Silvestri, F.**—La tignola dell' olivo. (*Prays oleellus*, Fabr.). Ibid., pp. 83-184, 68 figs.

**Silvestri, F., Martelli, G. e Masi, L.**—Sugli Imenotteri parassiti ectofagi della mosca delle olive fino ad ora osservati nel l'Italia meridionale. Ibid., pp. 18-82, 36 figs.

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This useful Circular is a reprint from the Yearbook for 1904, and treats of those species infecting chestnuts, pecan nuts, and hazel nuts.

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V.—FORESTRY.

**Gillanders, A. T.**—Forest Entomology. Pp. xxii + 422 and 351 figs. Edinburgh and London: William Blackwocd & Sons, 1908. Price 15s. net.

We extend a hearty welcome to Mr. Gillanders' new work, which is well printed and very fully illustrated.

The volume opens with an introduction treating of the general structure and classification of insects which might have been amplified with profit. This is followed by a somewhat imperfect account of the Gall-mites *(Eriophyidae)*, in which the absence of any reference to Mr. Gussow's and Dr. Nalepa's work on *E. rudis* is to be regretted.

Chapters 2 and 3 deal with the Coleoptera, and in our opinion are the best in the book. The figures are excellent and the descriptions concise, clear, and practical. The next two chapters are allotted to the Hymenoptera, a single one each to Coccidae, Lepidoptera, Aphididae, Diptera, and Psyllidae and Cicadidae.

The concluding chapters treat of collecting and preserving insects; insecticides and general remedies; beneficial insects; and a list of species and their food plants.

We must confess that we read the "Contents" with some surprise. Under the words Forest Entomology the author has included the *Eriophyidae* or Gall-Mites, and whilst classification will always be more or less arbitrary, that chosen by Mr. Gillanders is the strangest.

The omission of the common names of the various insects in not a few cases is a matter for regret, whilst a fuller acquaintance with the literature on Economic Entomology detracts in many cases from the value of the work.

Yet in spite of these minor blemishes the book is sound and certainly the best account of forest insects yet given by any British author, and we congratulate Mr. Gillanders on a piece of work well and ably carried out.

W. E. C.

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Translated from the *Archives de Parasitologie*, T. xi, No. 2.

**Montgomery, R. E.**—On a Spirochaete occurring in the Blood of Chickens in Northern India. Journ. Trop. Vet. Sci, 1908, vol. iii, pp. 1-12, plts. i, ii.

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THE

# JOURNAL OF ECONOMIC BIOLOGY.

## RATS AND THEIR ANIMAL PARASITES.[1]

By

A. E. SHIPLEY, M.A., Hon. D.Sc. (Princeton), F.R.S.,

*Fellow and Tutor of Christ's College, Cambridge, and Reader in Zoology in the University.*

THE overwhelming majority of rats fall under two species (i), *Mus rattus*, the black rat, and (ii) *Mus decumanus*, the brown rat. The original home of both species is, according to Dr. Blandford, Mongolia, but the date of their first appearance in our islands is a matter of some uncertainty. According to Helm *M. Rattus* passed into Europe at the time of the *Völkerwanderung*, and doubtless accompanied the migrating Asiatic hordes on their journeys westward. The name rat appears in early High Dutch glossaries; it is mentioned by Albertus Magnus, and occurs in early Anglo-Saxon writings in England. This evidence is, however, not conclusive that in those times the rat had entered Great Britain; indeed, according to Bell,[2] the black rat was not known here until before the middle of the sixteenth century, at least, he says, no author more ancient than that period has described, or even alluded to it as being in Great Britain, Gesner being the first to do so. Jenyns, in his Manual of British Vertebrate Animals,[3] describes *M. rattus* as "truly indigenous," but this is in comparison with the brown rat, whose comparatively recently arrival he chronicles. It is said to have been common on the continent of Europe in the thirteenth century.

*Mus rattus* has, as a rule, greyish-black fur above, ash-coloured below, with a tail a little longer than the body and head. It is smaller and more elegantly built than the brown rat, its snout is longer and more slender, and the long, thin, scaly tail is about 8 or 9 inches in length. The British forms average in length 7 inches from the tip of

[1] Read before the Association of Economic Biologists, Edinburgh Meeting, July 28th, 1908.

[2] A History of British Quadrupeds. 2nd Ed. London, 1874.

[3] London, 1833.

the nose to the origin of the tail. Although known as the black rat, its bluish, or greyish-black colour is, both in the East and in Northern America, frequently replaced by brown on the upper surface, and by white fur in the lower, or by a yellowish brown rufous colour. The ears, feet, and tail are black. When kept as pets—and they frequently are—white and pie-balded varieties are often bred. The ears are larger in proportion than *M. decumanus*, the rings of scales on the tail better marked, and spines in the fur are not uncommon.

The black rat, or Old English rat, begins to breed under the age of one year, and goes with young six weeks; it breeds frequently during the year, but does not commence in Bombay, according to the Plague Commission, until it has attained the weight of at least 70 grammes. In India they breed all the year round. In Britain they produce six to eleven young at a time; in India the average is 5.2; the largest number found by the Plague Commission having been 9. In Bombay it is noteworthy that in both species the percentage of young rats to the total rat population is greater during the warmer months—from June to October—than at other times of the year. It is also noteworthy that the fall in fertility begins before the onset of the plague Epizootic, though later it roughly coincides with it. In Britain they increase so fast as to overstock their abode, and thus they are forced, from deficiency of food, to devour one another, and this alone, Pennant thinks, "prevents even the human race from becoming a prey to them, not but there are instances of their gnawing the extremities of infants in their sleep."

The black rat is catholic as to its diet, omnivorous, and it devours every kind of human food. It is more domesticated than its congener, more devoted to human habitation, and it does immense damage to stored grain, seeds, and cereals. It is a better climber than *M. decumanus*, which accounts for its being *par excellence* the ship rat, since it can climb hawsers and more readily come on board. It makes its way up to the higher rooms of the tenement houses in Indian cities, where it nests and breeds undisturbed by the human inhabitants. Pennant[1] draws attention to the harm the black rat causes by gnawing and devouring not only edibles, but paper, cloth, water pipes, and even furniture. In England it makes a lodge, either for the day's residence, or a nest for its young, near a chimney, and "improves the warmth by forming in it a magazine of wool, bits of cloth, hay or straw." In the East it nests in the indescribable rubbish and "unconsidered trifles" the natives accumulate in their rooms, and is seldom, if ever, interfered with.

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[1] British Zoology, London, 1812.

Its climbing habits enable it to ascend trees, and in India it frequently nests among the branches. In some tropical islands *M. rattus* lives exclusively in the crowns of cocoa-nut palms, feeding almost entirely on their fruit.

Contrary to the opinion of Blandford, Oldfield Thomas thinks that the black rat originally came from India, and thence spread all over the world, exterminating the indigenous rats of other countries, only to be exterminated later by the arrival of the stronger *M. decumanus*. At the present time the last-named species is not yet established in some countries, for instance, in South America. On that continent, *M. alexandrinus*, a tropical variety of *M. rattus*, is waging war on the less highly organized native rice-rats or Sigmodontes. *M. alexandrinus* has a gray, or rufous back, and a white belly.

*M. rattus* has a milder, more amenable, and tameable character than *M. decumanus*, and the white, or pied varieties, so dear to school boys, are of this species. It is cleanly in its habits, and the skin is kept in excellent order. Like other rats, it holds its food in its hands whilst eating, and it drinks by lapping.

Although the black rat is tending to be driven out by the brown rat, it still lingers on in some warehouses in London, at Yarmouth, in Sutherlandshire, I believe in Lundy Island, and I have been told it occurred not so very long ago on the island in the Serpentine. It doubtless occurs in many other places.

*Mus decumanus*, the so-called brown rat, undoubtedly comes from Central Asia, and at the present time there is a rat in China described under the name, *M. humiliatus*, which is so indistinguishable from the brown rat that is thought to be the parent form.

The migration westward of the brown rat certainly took place much later than that of the *M. rattus*. Its first appearance is difficult to date. Undoubtedlv large hordes of them crossed the Volga in the year 1727, and continued their journey towards Central Europe. The following year, brown rats, according to Pennant, appeared in England—Jenyns says not till 1730—and it almost certainly came in ships, for on its journey overland it only reached Paris about the year 1750. Reaching England about the year of the second George's accession, and but thirteen years after the first of the House of Hanover succeeded to the throne, it was called, probably bv the adherents of the Stuart cause, the Hanoverian rat. It was also called the Norwegian rat, possibly from the mistaken idea that it reached these islands from that country. It has now passed to the Northern half of the New World, where it is gradually driving out many of its weaker brethren. Its numbers are, however, kept within certain limits by

wolves, lynxes, racoon, coyotes, opossums, and other carnivora, and especially by the skunks which enter barns and outhouses in search of them.

Until the discovery of America, the rat and mouse were unknown in the New World, and the first rats who ever saw it are said to have been introduced in a ship from Antwerp.[1]

The brown rat is of a grayish-brown colour, tinged with yellow and white beneath. The tail is not so long as the body. It is a larger rat than *M. rattus*, has shorter ears, a more powerful skull, and 10 to 12 mammae. Its ears, feet, and tail are flesh-coloured. Like *M. rattus*, colour varieties occur often, the melanistic, not uncommon in Ireland, being sometimes mistaken for the black rat. It is a larger animal than its congener, more heavily built, with a more powerful head, and blunt jaw. The head and body measure some 8 to 9 inches, but the tail, as a rule, does not surpass the length of the body alone. Its weight averages about nine ounces. It is extremely fierce, and extremely cunning, and in the struggle for existence with allied species, has hitherto been consistently successful in its fight.

*Mus decumanus* is very prolific, and produce several litters a year, each averaging 8-10 in number, but 12 or even 14 young are not very uncommonly born at one time. It begins breeding young, a half-grown female producing a litter of three or four, but in Bombay the sexes do not breed until they have attained at least a weight of 100 grammes. The young are naked, *i.e.*, without hairs, and of a beautiful pink colour. They are blind, and their ears are gummed down over the auditory meatus. They are very weak and helpless, and need that maternal care, which, to do the female rat justice, is never withheld.

*M. decumanus* is less attached to the dwellings of man than *M. rattus*, still it does live in houses, though owing to a lack of climbing power, it is never found above the third floor. It is largely a burrowing animal, and makes its nests in its burrows. *M. rattus* can also burrow, but not so readily, and it nests not in the burrow, but in some obscure corner. The brown rat frequents barns, granaries, stables, slaughter-houses, rivers, ponds, ditches, drains, gullies, and sewers; it is, in fact, sometimes called the sewer rat. It is less particular in its food than the black rat, which are more usually found in grain stores. Although in Bombay the relative numbers of *M. rattus* caught to *M. decumanus* was as seven is to three, in open spaces, gardens, etc., the latter was much the commoner. Yet the report of the Plague Commission states that the authors " do not think it an exaggeration to state

[1] Ovalle's History of Chili, in Churchill's Voyages. III, 45.

that every inhabited building in Bombay City and Island, not excepting even the better class bungalows, shelters its colony of *M. rattus*."

Both species readily take to water, though *M. rattus*, being the better climber, more readily gets on shipboard. They will swim rivers and arms of the sea. The rats which infest the London Zoological Gardens are said to nightly swim the canal in Regent's Park. Rats constantly make their way to coastal islands, and in a comparative short time clear the place of indigenous rabbits and birds. Puffin Island, off the coast of Anglesey, and the Copeland Islands, in Belfast Bay, are two examples of islands at one time leased for the sake of their rabbits to people who had to give up the lease after the rats had landed on them. Similar cases are known off Denmark. They eat greedily birds' eggs, and are said to convey them over considerable distances, though how they do this is not very clear. After the destruction of the vertebrate land-fauna, they fall back upon the dwellers in the littoral, and live on prawns, shrimps and molluscs. They are very fond of fish, and Lyddeker, in the Royal Natural History, states that they occasionally catch and eat young eels. As their parasites show, they eat insects such as the meal-beetle, and when in the field they eat land-snails, insect larvae, and other food, which conveys into their bodies the same tape-worms, etc., which we find in the hedgehog and in the smaller carnivora.

They are, in fact, omnivorous, and nothing in the way of human food is alien to them. They do enormous harm to corn ricks and to stored grain. They are inveterate enemies to the hen roost, the pigeon house and, as we have seen, to the rabbit warren. When pressed by hunger they readily turn cannibal, and the brown rat easily masters the black. There are stories of some few specimens of each species being left in a cage overnight; on the following morning there were only brown rats. To some extent they help to keep down the field mice (Genus *Microtus*), and this is especially the case in North America,[1] but the benefit is doubtful since they are held to be at least as destructive to the crops as the field mice, and probably more so.

The ferocity with which they defend themselves when attacked is well known, and at times, when they are driven by hunger, do not hesitate to attack man. They are said to nibble the extremities of infants, and on one—apparently authentic—instance they overcame and devoured a man who had entered a disused coal mine tenanted by starving rats. The bite is said to be severe (they will bite through a man's thumb nail into the flesh) and to be long in healing.

[1] An economic study of Field Mice (genus *Microtus*). Dr. Lantz, U.S. Dept. of Agric., Biol. Survey. Bull. 31.

Rats eat much garbage and offal, and readily feed upon dead bodies. About sixty years ago there stood at Monfaucon, a slaughter-house for horses, and this it was proposed to remove still further from Paris. It is stated that the carcases of the horses slaughtered, which sometimes amounted to thirty-five a day, were cleared to the bone by rats in the course of the following night. This excited the attention of a Mons. Dusaussois, who made the following experiment: He placed the carcases of two or three horses in an enclosure, which permitted the entrance of rats by certain known and closable paths. Towards midnight he and some workmen entered the enclosure, closed the rat-holes, and in the course of that night killed 2,650 rats. He repeated the experiment, and by the end of four days had killed 9,101 rats, and by the end of a month 16,050 rats. During the process of these experiments other carcases were exposed in the neighbourhood, so that in all probability Mons. Dusaussois attracted to his enclosure but a small proportion of the total available number of rats. All around this slaughter-house the country was riddled with extensive burrows, so that the earth was constantly falling in. In one place the rodents had formed a pathway 500 yards long leading to a distant burrow.

A rat census can never be taken, but estimating that there is one rat for every human being on these islands, or less than one rat for every acre of ground, a moderate estimate would give us 40,000,000 rats at any one time. It has been calculated that a rat does at least 7s. 6d. worth of damage during the course of the year, hence in Great Britain and Ireland we may annually charge them with a loss of at least £10,000,000.

From what has been said it is obvious that rats cause enormous damage to humanity, which is counterbalanced by the almost infinitesimal good they do as scavengers. I do not propose to consider in detail the harm they do as disease carriers, but I would remind you that the rat is the primary host of *Trichinella spiralis*, Owen, which, when conveyed from the rat to the pig, and—by eating uncooked or imperfectly cooked pork—from the pig to man causes severe and very fatal epidemics, and enforces the expenditure of large annual sums on meat inspection. They also convey a virulent form of equine influenza from one stable to another, and the "foot and mouth" disease. But what is infinitely more important than all the other injuries of all kind put together is the harm they bring to suffering humanity by conveying the bubonic plague from one patient to another. The plague under which India and great parts of Burmah is "groaning and travailing," is caused by a specific bacillus discovered in 1894 by Yersin at Hong Kong. It flourishes in other vertebrates besides man and the rat, but

owing to the migratory habits of the latter, the rat is the most effective agent in the spread of the disease. Both species of rat seem about equally susceptible, and the presence of the microbe showed no special relation to either the age or the sex of either species. The microbe is conveyed from rat to man by a flea. (v. p. 70).

The destruction of the rat is now being urged on all hands, and in the near future we shall probably see a considerable diminution in their numbers in the more civilized countries of the world. This will mean a considerable upset in the balance of power of the almost hidden fauna which surround us on all hands. It may even, as the Medical Officer of Health for Bristol has pointed out, lead to an increase of immigration of ship rats, those most likely to be infected by plague, to take up the places vacated on land by the slain. By one of those commercial agencies—I don't propose to go into the merits of any one of them—which the enterprise of our merchants is now pressing on the public, a large landed proprietor a few months ago completely freed his buildings of rats and mice. A few weeks later his house and outbuildings were overrun by swarms of what to him—for in the time of the rats and mice he had never seen one—was a new and formidable insect. He sought the aid of the Royal Agricultural Society, who referred the matter to their scientific adviser, who pronounced the insects to be cockroaches!

In the eighteenth century, among the officers of his "British Majesty," was an official rat-catcher, whose special uniform was scarlet, embroidered in yellow worsted, with figures of field mice destroying wheat sheaves. Enquiry at the Lord Chamberlain's office has satisfied me that the officer still exists and still catches rats, but I fear the uniform has been abolished. However, a book has recently appeared dealing officially and exhaustively with all matters of this kind, and as soon as I can come by it I will look the matter up. Should this dignified uniform have really disappeared, might not a humble petition be presented that it be revived? Surely never more than at the present time should the honour and glory of the rat-catcher be exalted.

## ECTOPARASITES OF THE RAT.

### INSECTA.

#### A. SIPHONAPTERA (FLEAS).[1]

**1.—Ceratophyllus fasciatus,** Bosc.

This is the flea most commonly found on *Mus rattus* and on *M. decumanus* in Great Britain and indeed throughout Central and Northern Europe. It also occurs on the house-mouse *M. musculus.* Rats from Cape Town also harbour this species, and it is occasionally found on rats from India.

**2.—Ceratophyllus londiniensis,** Rothschild.

Synonym. *Ceratophyllus italicus*, Tiraboschi.

Very common on both species of rats and allied forms. Apparently this species does not bite man.

**3.—Ceratophyllus consimilis,** Wagner.

**4.—Ceratophyllus lagomys,** Wagner.

**5.—Ceratophyllus mustelae,** Wagner.

**6.—Ceratophyllus penicilliger,** Grube.

Numbers 3, 4, 5 and 6 are all very common fleas on *Mus decumanus*, though Tiraboschi has not found them in Italy. Systematically they are allied to *Ceratophyllus faciatus*, Bosc.

**7.—Ctenocephalus canis,** Curtis.

Occurs chiefly on the dog, but has been found on many Carnivores, on hares and rabbits, monkeys and man, and the rat. In Italy some 25-30 per cent. of rat-fleas belong to this species. The members of it are unusually agile and are great jumpers.

**8.—Ctenocephalus felis,** Bouché.

Found on cats and also on rats; like the preceding species, it is found widely distributed in the Old World. Mr. Rothschild tells me there is no doubt that these two species are distinct.

[1] Rothschild, N. C. Jour., *Hygiene* vi, 1906, p. 483.

### 9.—**Ctenopsylla musculi**, Duges.

Is the commonest flea found on the domestic mouse in our country, and it sometimes makes its way to the rat; it has been taken from *M. rattus* in Pretoria, and in Italy is the commonest flea on that species. It seems to be cosmopolitan in its distribution.

### 10.—**Dermatophilus caecata**, Enderlein.

The genus *Dermatophilus* (Guerin) Rothschild, with the genera *Echidnophaga* and *Hectopsylla*, comprise the family SARCOPSCYLLIDAE, which includes the Jiggers or Chigos, whose females burrow in the skin. *D. caecata* is recorded from *Mus rattus* taken in San Paulo in Brazil.

### 11.—**Echidnophaga, rhynchopsylla**, Tiraboschi.

Synonym. *Echidnophaga murina*, Rothschild.[1]

This flea, which Dr. Tiraboschi found on *Mus rattus* in Italy, usually upon the heads and snout, is interesting because it, with *E. gallinacea*, are the only two species of the family SARCOPSYLLIDAE so far recorded in Europe. It is nearly allied with *E. gallinacea*. The females all had their heads solidly embedded in the skin of the host.

### 12.—**Echidnophaga gallinacea**, Westwood.

Synonym. *Echidnophaga gallinacea*, Tiraboschi.
*Argopsylla gallinacea*, Baker.
*Echidnophaga gallinacea*, Rothschild.

Tiraboschi has taken this, which he considers a species distinct from *E. rhynchopsylla* from *Mus rattus* in Italy.

### 13.—**Neopsylla bidentatiformis**, Wagner.

Taken on *Mus decumanus* in the Crimea and on *Spermophilus* sp. in Siberia and the Caucasus.

### 14.—**Loemopsylla cheopis**, Roths., 1903.[2]

Synonym. *Pulex murinus*, Tiraboschi.
*Pulex pallidus*, Tidswell.
*Pulex philippinensis*, Herzog.
*Pulex brasiliensis*, Baker.

This flea was described by Rothschild from specimens taken from numerous small rodents in Egypt. Tiraboschi found it commonly in

[1] Rothschild, N. C., Rep. Thompson Yates and Johnston Lab., Liverpool, vii (new ser.), 1906, p. 55.

[2] Jordan, K. and Rothschild, N. C., Parasitology, 1908, vol. i, p. 42.

Italy, and on 40% of the ship rats in Genoa. It occurs on from 80% to 90% of the rat population of Sydney and Brisbane, where it was described by Tidswell[1] under the name of *Pulex pallidus*, and on 25 per cent. of the rats in Marseilles, where Gauthier and Raybaud[2] record that the numbers decrease as the distance from the water-front increases. Herzog[3] took 42 fleas of this species from 153 rats of both species in Manila, and it also occurs commonly in South America. It has been found at Plymouth and at Pretoria. It is by far the commonest of the rat fleas of warmer countries, and the Plague Commission consider that it forms 99 per cent. of the fleas found on *Mus rattus* and *M. decumanus* in India.

This species readily passes on to monkeys, guinea-pigs, and man, and we have seen it lives on many wild rodents. It is now recognized as the chief means by which the plague is conveyed from rats to man.

### 15.—**Pulex irritans,** Linn.

This, the common human flea, has been found biting both *Mus rattus* and *M. decumanus*, as well as many other animals which come in contact with man.

According to this list the following species occur on *Mus decumanus*, but not on *Mus rattus*:—*Ceratophyllus consimilis*, *C. lagomys*, *C. mustelae*, *C. penicilliger* and *Neopsylla bidentatiformis*; whilst *Dermatophilus caecata*, *Echidnophaga rhynchopsylla* and *E. gallinacea* occur on *Mus rattus* and not on *Mus decumanus*. Further investigations will very likely reduce these two lists.

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## B. ANOPLEURA—LICE.

Enderlein[4] has recently separated out from the genus *Haematopinus* certain forms which he places in two new genera *Hoplopleura* and *Polyplax*.

### 16.—**Hoplopleura acanthopus** (Drury).

Synonym. *Haematopinus acanthopus*, Drury.

This is figured and described by Tiraboschi[5]; it occurs on *Mus decumanus*, on the mouse, and on several species of wild Muridae.

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[1] Tidswell, F., Report on the Second Outbreak of Plague at Sydney, 1902, by Ashburton Thompson.

[2] Gauthier and Raybaud, Rev. d'Hygiène xxv, 426.

[3] Herzog, M. Zeitschr. Hygiene, li, p. 268.

[4] Zool. Anz., xxviii 1904-5, pp. 121, 220, 626, and xxix, 1905-6, p. 192.

[5] Arch. parasit. viii, 1903-4, p. 318.

### 17.—**Polyplax spinulosus** Burm.

Synonym. *Haematopinus spinulosus*, Burm.

This louse has been found by many observers on *Mus decumanus*, and has been recently figured and described by Tiraboschi.[1] It is believed to act as the intermediate host of *Trypanosoma lewisi.*

### 18.—**Pediculus capitis,** Nitzsch.

This species is thought occasionally to infest the rat. They are known to suck the blood of rats when placed on them, and they are capable of transferring the plague to man. It is thought that this may be not unfrequent amongst the sect known as Janis, to whom all life is sacred, and who are consequently exceptionally verminous.

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## ARACHNIDA.

### ACARINA.

### DEMODICIDAE.

### 19.—**Demodex musculi,** Oudemans.[2]

It seems doubtful if this is but a variety of *Demodex folliculorum*, which lives in the sebaceous glands and hair follicles of man. It has been found in the mouse and in rats, but the species is not stated

### IXODIDAE.

### 20.—**Ixodes ricinus,** L.

Synonyms. *Acarus ricinus*, L.
*Ixodes rufus*, Koch.
*Ixodes sulcatus*, Koch.
*Ixodes sciuri*, Koch.

This, one of the commonest of ticks in temperate climes, and one which occurs on a very large number of very diverse animals, has been recorded by Neumann on *Mus decumanus*.

### 21.—**Hyalomma aegyptium,** L.

Synonyms. *Acarus aegyptius*, L.
*Ixodes aegyptius*, Andouin.
*Hyalomma marginatum*, Koch.
*Hyalomma aegyptium*, Canestrini.

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[1] Arch. parasit. viii, 1903-4, p. 316.
[2] Tijdschr. Ent. 1897.

Larval specimens of this genus have been identified by Professor Nuttall, which was collected off *Mus rattus* in Nowshera, North-West Frontier Province, India. This species is commonest on cattle. It also occurs on man, and gives rise to serious fevers.

### 22.—**Rhipicephalus sanguineus,** Latr.

Synonyms. *Ixodes sanguineus*, Latr.
*Ixodes dugesi*, Gerv.
*Rhipicephalus sanguineus*, Koch.
*Rhipicephalus siculus*, Koch.

Adult forms of this species occurred on the same rats as did the *Hyalomma aegyptium*, and were also identified by Professor Nuttall. It infests cattle, sheep, dogs, cats, and occasionally man. This species is common in Italy and France.

## GAMASIDAE.

### 23.—**Laelaps agilis,** Koch.

Found on *Mus decumanus* and many other allied forms. The members of the genus *Laelaps* suck blood.

### 24.—**Laelaps echidninus,** Berlese.

Synonyms. *Laelaps agilis*, Koch.
*Haemomyson musculi*, Megnin.

Common on *Mus decumanus* and *Mus rattus* in all parts of Italy. It occurs in large numbers, 150-200 on a single rat.

### 25.—**Laelaps stabularis,** Koch.

Synonyms. *Gamasus stabularis*, Koch.
*Gamassus complanatus*, Kramer.
*Gamassus fenilis*, Megnin.
*Hypoaspis stabularis*, Canestrini.

This form, common in stables, has been found on *Mus decumanus*.

### 26.—**Myonyssus decumani,** Tiraboschi.[1]

A single adult female, taken on a *Mus decumanus*, captured at Rome, was described and figured by Tiraboschi. Members of this genus are true parasites, living on the blood of their host.

[1] Arch. Parasit. viii, 1903-4, p. 337.

### SARCOPTIDAE.

27.—**Notoedres alepis,** Railliet and Lucet.[1]

Synonym. *Sarcoptes notoedres var muris*, Megnin, 1820.
*Sarcoptes alepis*, Raill. and Luc., 1893.
*Notoedres muris*, Can., 1894.
*Notoedres notoedres*, Can and Kramer, 1899.

This species lives in the ears, and on the external genital organs of *Mus decumanus* and of *Mus rattus*, and other Muridae in France, but it does not appear to do much harm. The genus *Notoedres* is allied to *Sarcoptes*, the itch-mite, and they have similar habits.

### TROMBIDIDAE.

28.—**Myobia ensifera,** Poppe.

Found on a *Mus decumanus* from a house, also on white rats. It is not impossible that this and the succeeding species are identical.

29.—**Myobia musculi** Schrank.

Synonyms. *Pediculus musculi*, Schrank.
*Myobia coarcta*, Heyden.
*Myobia musculi*, Claparède.

This is commoner on the mouse, living at the base of the hairs on the head, but Megnin also records it on the *Mus decumanus*.

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## ENDOPARASITES OF THE RAT.

### PROTOZOA.

The number of Protozoa recorded as parasitic in the rat is disappointingly small, and a renewed search would doubtless largely increase the number. In his exhaustive article on Sporozoa in Lankester's "Treatise of Zoology," Profesor Minchin mentions but one Protozoan parasite *Sarcocytis* sp. (Siehold, 1853) from the rat, though he records three from the mouse. Professor Minchin has kindly sent me the names of some more protozoan endoparasites, which are mentioned below, but I feel sure the list is by no means exhaustive.[2]

[1] C. R. Soc. Biol., 1893, p. 404.

[2] See also "Observations on the Protozoa in the Intestine of Mice," by C. M. Wenyon, Arch. Protistenk. Festb. z, R. Hertvig, Suppl. I, p. 169. Many of the Protozoa described here probably also invest the Rat.

### 1.—**Amoeba muris,** Grassi.[1]

The life-history of this form, which occurs in mice as well as rats, has recently been described by Wenyon.

### 2.—**Leucocytozoon muris,** Balfour.[2]

Balfour has described this species from *Mus decumanus*, finding it in two specimens out of a dozen examined. It occurred in the blood of the heart and of the spleen, and free forms were found as well as those living in the leucocytes.

### 3.—**Sarcocystis,** s.p.

This parasite was first found by Meischer in the muscles of a house mouse, and is figured and shortly described by von Siebold,[3] who found specimens, as did also Herr Bischoff, in the muscles of a rat —species not mentioned. It is possible that this incompletely described Sarcosporidian is identical with *Sarcocystes muris* (Blanchard), a very deadly parasite in mice, according to Koch.[4] A virulent poison has been extracted from a Sarcosporidian parasitic in the sheep by Laveran and Mesnil, and named by them *sarcocystin*.

### 4.—**Piroplasma muris,** Fantham.[6]

Fantham has made a careful study of certain phases in the life-history of this blood parasite, which he found in the blood of the *Mus rattus*, the white variety. It occurred but seldom in the peripheral circulation, and was most plentiful in the red corpuscles of the blood in the capillaries of the viscera and nervous system, especially in the liver, kidneys, and spleen. Extra-corpuscular forms occurred in groups. The complete life-history of this form has not been worked out.

### 5.—**Trypanosoma lewisi,** Kent.

The history of this common parasite of the rat is given in Laveran and Mesnil's "Trypanosomes et Trypanosomiases."[7] The infection seems to occur all over the world, in both *Mus decumanus* and *Mus rattus*, but the percentage of infected rats varies greatly in different

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[1] Atti. Soc. Ital. Sci. Nat., xxiv, 1882, p. 181.

[2] Grassi's authority. Second Report of the Welcome Research Laboratories, Khartoum, 1906, p. 110.

[3] Zeitschr. wiss. Zool., v, 1854, p. 199.

[4] Verh. v. Int. Congr. Zool., Berlin, 1901 (1902), p. 674.

[5] CR. Soc. Biol., Paris (II) i, 1899, p. 311.

[6] Quart. J. Micr. Sci., L, 1906, p. 493.

[7] Paris, 1904.

localities, and at different times. Nuttall[1] recalls the experiments of Rabinovitch and Kempner (1899), who claim to have infected healthy rats by placing on them fleas taken from the bodies of infected specimens. The species of flea is not mentioned. Prowazek (1905) has observed the development of *Tr. lewisi* in one of the rat-lice, *Polyplax spinulosus*, and though he did not succeed in transmitting the disease from rat to rat by means of lice, he concluded that such conveyance was possible in certain cases.

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## METAZOA.

The following Nematodes and Cestodes entozoa have been found in the *Mus rattus*:—

### A. NEMATODA.

#### 6.—**Heterakis spumosa,** Schneider.[2]

This species is found in the caecum and large intestine of both *M. rattus* and *M. decumanus*. The male attains a length of 7 mm., the female of 9 mm.

#### 7.—**Oxyuris obvelata,** Bremser.

Synonym. *Ascaris oxyura*, Nitzsch.[3]

This small thread worm measures in length in the male 1.6 mm., in the female 3-5 to 5-7 mm. It lives in the intestine, mostly in the large intestine. It inhabits many species of *Mus* and of *Arvicola*, also *Spermophilus citillus*, and is much commoner in the "country mouse" than in the "town mouse." As is usual the males are less abundant than the females, but are more easily found than is usual in this genus. The worms swell up, and sometimes burst by the osmotic absorption of water when placed in that fluid.

#### 8.—**Physaloptera circularis,** von Lins.[4]

This species, which measures in the female 24 mm., and in the male 15.2 mm., was described by von Linstow from specimens taken from the stomach of a *M. rattus* collected in Madagascar bv F. Sikora. Von Linstow mentions that with the exception of *Ph. muris brasiliensis*, Molin, it is the only *Physaloptera* which inhabits rodents.

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[1] Ber. ü. d. xiv, Intern. Kongr. f. Hyg. u. Demogr, Berlin, 1907, p. 200.

[2] Schneider, A. Monog. d. Nemat. Berlin, 1866. p. 77.

[3] Ersh. u. Grub. Encyclop., vi, p. 84; Creplin, Wiegmann's Archiv., 1849, p. 56; Dujardin, Hist. Nat. d. Helminthes. Paris, 1845, p. 141; Diesing Syst. Helminth., Vienna, 1851, p. 145.

[4] Arch. Naturg., lxiii, i, 1897, p. 28.

### 9.—**Spiroptera brauni,** von Lins.[1]

This species was also described and figured by von Linstow, and from a *M. rattus* taken in Madagascar. The male measures 19 mm. in length, the female 54 mm.

### 10.—**Spiroptera ratti,** Diesing.[2]

This species is mentioned in von Linstow's Compendium, but I have been unable to find the magazine in which it is described in any of the Cambridge libraries. *S. ratti* lives in the urinary bladder.

### 11.—**Spiroptera sp.,** Bakody.[3]

This insufficiently described species is mentioned in a letter by Dr. Bakody of Pesth. He describes it as encapsuled in the walls of the alimentary canal, and in certain muscles of both *M. rattus* and *M. decumanus.*

### 12.—**Trichocephalus nodosus,** Rud.[4]

The male is 14-20 mm. in length, the female 23-31 mm.; the eggs, with the characteristic "tampons" at each end, measure 0.57 by 0.62 mm. This species occurs in *M. rattus,* and the house mouse *M. musculus,* and the wood mouse *M. sylvaticus,* and in species of *Arvicola.* It lives in the caecum, but is sometimes found in the intestine.

### 13.—**Trichosoma annulosum,** Duj.[5]

This form is shortly described by Eberth, and is figured by him. It occurs in the duodenum and small intestine of both *Mus rattus* and *M. decumanus.* Its development is probably direct, without the intervention of an intermediate host.

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## B. CESTODA, ADULT FORMS.

### 14.—**Cattotaenia pulsilla,** Goeze.[6]

Synonym. *Taenia pulsilla,* Goeze.

This species lives in the small intestine of *Mus rattus* and *M. decumanus.* For it von Janicki has recently established the new genus *Cattotaenia.*

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[1] Arch. Naturg., lxiii, i, 1897, p. 30.

[2] Gurlt, Magaz. für d. gesammete Thierheilk., 1838, p. 226.

[3] Archiv path. Anat. u. Physiol, xxxvi, 1866, p. 435.

[4] Dujardin, Hist. Nat. d. Helminthes., Paris, 1845, p. 35; and Goeze, Naturg. d. Eingeweidew. Blankenburg, 1782.

[5] Eberth, C. J. Untersuch. über Nematoden, Leipzig, 1863, p. 57.

[6] Goeze, J. A. E., Naturg. d. Eingeweidewürmer, Blankenburg, 1782. Archiv. Naturg. 1862, I. p. 205., von Janicki, C. Zeitschr. wiss. Zool., lxxxi, 1906, p. 575, and Zool. Anz., xxxviii.

### 15.—**Hymenolepis diminuta**, Rudd.[1]

Synonyms. *Taenia diminuta*, Rud, 1819.
*Taenia leptocephala*, Creplin, 1825.
*Taenia flavo-punctata*, Weinland, 1858.
*Taenia varesina*, Parona, 1884.
*Taenia minima*, Grassi, 1886.

The length of this worm is from 20-60 cms. Its second host lives in various insects, a butterfly *Asopia farinalis*, an Orthopteron *Anisolabis annulipes*, and certain beetles *Akis spinosa* and *Scaurus striatus*. Of these perhaps the first is the more frequent intermediary. The worms can be found in the rat's intestine three days after it has fed on infected insects; they attain a length of 5 mm., and at the end of fifteen days they have well-developed proglottides. *H. diminuta* occurs in the intestine of *Mus rattus*, *M. decumanus*, *M. musculus*, *M. alexandrinus*, and occasionally of man. It forms one of the three unarmed species of *Hymenolepis* which infest the genus *Mus*.

### 16.—**Hymenolepis microstoma** Duj[2]

Synonym. *Taenia microstoma*, Duj.

The length of this worm is 162 mm. It lives in the intestines of *Mus rattus* and *M. musculus*. It is one of the four armed species of *Hymenolepis* which live in the genus *Mus*.

### 17.—**Hymenolepis murina** Duj.[3]

Synonym. *Taenia murina*, Duj, 1845.
*H.* [*Lepidotrias*] *murina*, Weinland, 1861.

This worm measures from 25-40 mm. Grassi considers this species as identical with *H. nana* of the small intestine of man. He further thinks that *H. murina* develops without an intermediate host, and claims to have infected rats by feeding them on the mature proglottides of the worm. He describes the larval stages as developing in the thickness of the mucosa at the base of the villi. Here they increase markedly in size, and turn into cysts, which ultimately rupture the mucosa in which they are imbedded, and make their way into the intestine, where they

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[1] Dujardin, M. F. Hist. nat. des Helminthes., Paris, 1845, p. 580, and Zschokke, F. Recherches sur la structure des Cestodes. Geneva, 1888., von Janicki, C. Zeitschr. wiss. Zool., lxxxi, 1906, p. 581.

[2] Dujardin, M. F., Hist. nat. des Helminthes, Paris, 1845, von Janicki Zeitschr, wiss. Zool., lxxxi, 1906, p. 581.

[3] Dujardin, M. F., Hist. nat. d. Helminthes., Paris, 1845, von Janicki, C. Zeitschr, wiss. Zool., lxxxi, 1906, p. 581.

quickly become adults. If this life-history be true, it forms an exception—unique as far as I know—of a cestode which passes both its larval—cysticercus—and its adult—scolex—stage within the body of one and the same host. *H. murina* occurs in *Mus rattus*, *M. decumanus*, *M. pumilus*, *M. musculus*, and *Myoxus quercinus*. Rats infested with *H. murina* are particularly resistant to the attacks of other Cestodes. It is one of the four armed species of *Hymenolepis* which inhabit the genus *Mus*.

### 18.—**Taenia ratti**, Rud.[1]

This form again wants reinvestigation. It occurs in the intestine of *Mus rattus*. Von Janicki considers it a species of very doubtful validity.

### 19.—**Taenia umbonata**, Molin.[2]

Another intestinal form which occurs in *Mus rattus* and *M. musculus*. Von Janicki[3] considers this a doubtful species, and Blanchard[4] thinks it may be identical with *Cattotaenia* (*Taenia*) *pulsilla*.

### 20.—**Bothriocephalus ratticola**, von Lins.[5]

This animal was found encysted in the liver of a rat from Singapore. It measured 12 cms., but is undoubtedly a larval form, such as is common in fish.

## CESTODA, LARVAL FORMS.

### 21.—**Taenia crassicollis**, Rud, 1810, larval form **Cysticercus fasciolaris.**

The adult form of this tape-worm is a parasite of the small intestine of the cat, both wild and domesticated, and also of some species of *Putorius*. The larval form—*Cysticercus fasciolaris*—has a very small cyst, from which the head protrudes, followed by a long, and clearly ringed neck, but without, as yet, any trace of reproductive organs. The length of the worm varies from 3-20 cms. On being swallowed by a cat the small vesicle and these rings are absorbed, and the proglottides are formed anew at the base of the head. The cysticercus occurs in the liver of rats, mice, and bats.

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[1] Rudolphi, C. A., Entozoorum Synopsis, Berolini, 1819.

[2] SB. Ak. Wien, xxx, 1858, p. 132.

[3] Zeitschr, wiss. Zool., lxxxi, 1906, p. 582.

[4] Hist. Zool. et méd des Témiadés du genre *Hymenolepis*. Bibl. gèn. de Médecine. Paris, 1891.

[5] Centrbl. Bakter., xxxvii. 1904, p. 682.

22.—**Taenia solium,** L. larval form **Cysticercus cellulosae.**

The cystic form of *T. solium*, usually found in pork, is from time to time found also in the rat, encysted in the peritoneum. There is nothing surprising in this as rats are omnivorous, eating every kind of garbage, and frequenting both the homes of humanity and the styes of pigs.

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## C. ACANTHOCEPHALA.

23.—**Gigantorhynchus moniliformis,** Bremser.[1]

Synonym. *Echinorhynchus moniliformis*, Bremser.

This species of Acanthocephalan inhabits various species of *Arvicola*, *Cricetus* the Hamster, *Myoxus*, and *Mus*, including *M. rattus* and *M. decumanus*. It can also infest man. The larval stage is passed in the common beetle *Blaps mucronata*, Latr.

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The following Entozoa live in the brown, Hanoverian, Norwegian rat, *Mus decumanus*:—

## A. NEMATODA.

24.—**Filaria obtusa,** Rud.[2]

Synonyms. *Spiroptera obtusa*, Rud.
*Spiroptera murina*, Leuck.

These Nematodes are found sometimes in great numbers in the stomachs of *M. decumanus* and *M. musculus*. The female averages 40 mm. in length, the male 28 mm.

25.—**Filaria rhytipleuritis,** Deslongchamps, 1824.

This form has been found in the stomach of *M. decumanus*; its larval stage is believed to be the *Mermis blattae orientalis* of Diesing, which occurs in the fat-bodies of the blackbeetle *Periplaneta orientalis*[3] The female attains a length of 20 mm., the male is shorter. *Mus rattus* has been artificially infected with this thread-worm, and probably it is readily infected in nature.

[1] Bremser, J. C., Icones Helminthum, Vienna, 1824. Hamann, O. Zool. Anz., xv. 1892, p. 165.

[2] Schneider, A. Monog. d. Nematoden. Berlin, 1866, p. 97.

[3] Galeb, O., C. R. Ac. Paris, lxxxvii, 1878, p. 75.

### 26.—**Filaria sp.** Davaine.[1]

Darvaine is said to have mentioned some microfilarias he had discovered in the blood of the rat, but their parentage is still a matter of doubt. I have not succeeded in finding the place referred to.

### 27.—**Heterakis spumosa,** Schneider.

*v.* No. 6, p. 75.

### 28.—**Oxyuris obvelata,** Bremser.

*v.* No. 7, p.75.

### 29.—**Spiroptera sp.** Bakody.

*v.* No. 11, p. 76.

### 30.—**Strongyloides longus,** Grassi and Segrè.[2]

Synonym. *Rhabdonema longum*, Grassi and Sergè.

This form is larger than the *Str. intestinalis* of the human intestine. Its length is variable, but may reach 6 mm. It was first found in the rabbit, but has since been recorded from the sheep, the pig, the weasel, the pole-cat, and the brown rat. The development is direct, without the intervention of any intermediate host.

### 31.—**Trichina circumflexa,** Polonio.[3]

This form, which may very probably be identical with *Trichinella spiralis*, is mentioned by von Linstow as a parasite of *M. decumanus*, but Polonio attributes it to *Mus rattus*, probably both act as hosts. It occurs encapsuled in the peritoneum.

### 32.—**Trichinella spiralis,** Owen.

Synonym. *Trichina spiralis*, Owen.

This is the most important of the metazoan parasites of the rat from the human point of view, since the rat is probably the natural host from which the pig and man acquire the terrible disease of Trichinelliasis. The embryos occur encysted in the muscles, and the adults live in the intestine. It is also found in the hamster, the mouse, and other rodents.

### 33.—**Trichocephalus hepaticus,** Bancroft.[4]

Bancroft describes the livers of rats fed on large numbers of eggs of this worm as becoming riddled with the adults, which cause death

[1] Davaine Traité des Entozoaires.
[2] Rend. Ac. Lincei (4), iii, p. 100, 1887.
[3] Lotus, 1860, p. 23.
[4] P. R. Soc. N.S. Wales, xxvii, 1893, p. 86.

in three to four weeks. The worms are 40-50 mm. in length. The development is direct without intermediate host.

I think there is little doubt that this form is identical with *Trichosomum tenuissimum* described by Leidy[1] two years before.

34.—**Trichodes crassicauda,** Bellingham.[2]

Synonym. *Trichosoma crassicauda,* Bellingham.

This worm lives in the urinary bladder, the kidneys, the ureter of *Mus decumanus.* It is described and figured by von Linstow, who says the eggs, whilst unlaid, contain embryos with a boring spine, which can be protruded and retracted. The development is probably direct. Sometimes the worms, which may be numerous, are free in the bladder sometimes attached to the wall, they are often enveloped in mucous. The males, which are very small, are said to live like the males of *Bonellia,* in the uterus of the female, three or four at a time.

35.—**Trichosoma aunulosum,** Duj.

*v.* No. 8, p. 76.

36.—**Trichosoma papillosum,** Polonio.[3]

This is also a parasite of the urinary bladder, and may prove to be a synonym of *Trichodes crassicauda.*

37.—**Trichosoma schmidtii,** v. Lins.[4]

Von Linstow has described and figured the male of this species, which appears to be very small and very rare. It lives in the urinary bladder of *M. decumanus.*

38.—**Trichosoma tenuissimum,** Leidy.[5]

Synonym. *Trichocephalus hepaticus,* Bancroft.

*v.* No. 33, p. 80.

39.—**Trichosoma sp.** Railliet.[6]

This form also seems to me to be, in all probability, identical with Leidy's *Trichosoma tenuissimum,* v. No. 10 p. 80. An identical or closely similar form makes tumours in the liver of the hedgehog.

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[1] P. Ac. Philad., 1890, p. 412.

[2] Eberth, J. Untersuchungen über Nematoden. Leipzig. 1863, p. 61. von Linstow, O. Arch. Naturg., xlviii, i. 1882, p. 12.

[3] Lotos, 1860, p. 23.

[4] Arch. Naturg., xl, i. 1874. p. 271.

[5] P. Ac. Philad., 1890, p. 412.

[6] Bull. Soc. Zool., France, xiv, 1889, pp. 62 and 360.

## B. TREMATODA.

### 40.—**Distoma spiculator,** Duj.[1]

Under the above name Dujardin describes six immature individuals which he found in the small intestine of a specimen of *M. decumanus* taken at Rennes. He somewhat curiously adds that he believes them to be young specimens of *D. trigonocephalum*, since the rats in the country devour molluscs and insects as much as do small carnivora, hedgehogs, etc., which harbour the trematode.

## C. CESTODA, ADULT FORMS.

### 41.—**Cattotaenia pulsilla,** Goeze.

*v.* No. 14, p. 76.

### 42.—**Hymenolepis diminuta,** Rud.

*v.* No. 15, p. 77.

### 43.—**Hymenolepis horrida,** v. Lins.

Synonym. *Taenia horrida*, v. Lins.[2]

Length 80 mm. This is one of the unarmed forms, and is allied to *H. relicta* and *H. diminuta*.

### 44.—**Hymenolepis murina,** Duj.

*v.* No. 17, p. 77.

### 45.—**Taenia brachydera,** Dies.[3]

This worm was found in the small intestine of the *Mus decumanus* in Ireland by Dr. O'B. Bellingham.[4] Von Janicki[5] considers it a doubtful species, and mentions that Blanchard thinks it may be identical with *H. microstoma*.

## CESTODA, LARVAL FORMS.

### 6.—**Taenia crassicollis,** Rud, 1810, larval form **Cysticercus fasciolaris.**

*v.* No. 21, p. 78.

[1] Dujardin, M. F. Histoire Naturelle des Helminthes, Paris 1845, p. 424.
[2] Arch. Naturg, lxvii, i, 1901, p. 1.
[3] S.B Ak. Wien, xiii, 1854, p. 607.
[4] Ann. Nat. Hist., xiv, 1844, p. 322.
[5] Zeitschr, wiss. Zool., lxxxi, 1906, p. 582.
[6] Hist. zool. et. med. des Téniades du genre *Hymenolepis*. Bibl. gèn. de Médecine. Paris, 1891.

## D. ACANTHOCEPHALA.

### 1.—**Gigantorhynchus moniliformis** Bremser.

*v.* No. 23, p. 79.

### THE CESTODA OF THE GENUS MUS.

Von Janicki has recently put together a list of the adult Cestodes inhabiting the intestines of various members of this genus. Apart from some species insufficiently described, the list contains the following species; the names of those underlined occur in *Mus rattus* and *Mus decumanus*, or in one of them:—

i. Cattotaenia pusilla, Goeze, in both rats.
ii. Davainea blanchardi, Parona.
iii. Davainea celebensis, Janicki.
iv. Davainea polycalceola, Janicki.
v. Davainea gracilis, Janicki.
vi. Davainea trapezoides, Janicki.
vii. Hymenolepis contracta, Janicki, *M. decumanus.*
viii. Hymenolepis microstoma, Dujardin, *M. rattus.* **with armed heads.**
ix. Hymenolepis murina, Dujardin, in both rats.
x. Hymenolepis muris variegati, Janicki.
xi. Hymenolepis diminuta, Rudolphi, in both rats.
xii. Hymenolepis horrida, von Linstow, *M. decumanus.* **with unarmed heads.**
xiii. Hymenolepis relicta, Zschohke.
xiv. Hymenolepis crassa, Janicki, *M. decumanus.* **Scolex unknown.**
xv. Hymenolepis, sp., Janicki, *M. decumanus.*

There are further certain doubtful species, amongst which von Janicki reckons *Taenia ratti*, Rud., *T. muris sylvatici*, Rud., *T. muris capensis*, Rud., *T. musculi. Ptychosphysa* (*Mesocestoides*) *lineata*, Goeze = (*Taenia canis lagopodis*, Viborg), though said to occur in *Mus musculus*, apparently does not do so. The *Taenia imbricata* of Diesing and the *T. umbonata* of Molin are thought to be identical with *Cistotaenia pusilla*, Goeze, whilst *T. brachydera*, Diesing, is probably synonymous with *Hymenolepis microstoma.*

Cambridge, July, 1908.

# THE LIFE-HISTORY OF SYAGRIUS INTRUDENS, WATERH.

## A Destructive Fern-eating Weevil.[1]

By

JOSEPH MANGAN, B.A., A.R.C.Sc. I.

WITH PLATES VI AND VII.

THE following description of the larva, pupa, and imago of *Syagrius intrudens*, may be of interest in view of the possible importance of that, and perhaps of allied species, to those concerned with the culture of Ferns. Up to the present it has been recorded solely from the Royal Botanic Gardens, Dublin, where, however, it has proved to be a most persistent and exceedingly destructive pest. For some time the Keeper of the Gardens, Mr. F. W. Moore, was troubled by the decided falling off and even complete collapse of very many of the exotic specimens in the fern-houses; the cause of these failures being by no means apparent, until an examination of the rhizomes of plants that had succumbed, or were fading, revealed the presence of this weevil. The mature insect was never to be seen above the ground during the day-time, but under cover of darkness it did considerable damage to the fronds; while the larvae, boring through the rhizomes and leaf-stalks, hollowed out the centre, eventually killing the plant. Mr. C. O. Waterhouse, (1) of the British Museum, described the weevil as a new species belonging to the Australian genus *Syagrius*. Prof. G. H. Carpenter (2) subsequently published a report of its occurrence, together with an account of the steps taken to exterminate it. I am indebted to Mr. F. W. Moore for giving me every facility for observing and procuring specimens of the insect.

### HABITS.

The eggs of the weevil are deposited singly in a deep pit, which is indicated externally by a small round puncture on the leaf-stalk or on the rhizome. I have been unable to determine the period of hatching. The soft, white grubs, spend all their life burrowing through the larger portions of the stems, and even in the hardest parts of the rhizome, and are found rather sparely on specimens that have been attacked. One or two grubs, I have noticed, are able to execute a good deal of

[1] Read before the Association of Economic Biologists, Edinburgh Meeting, July 29th, 1908.

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damage, the duration of the larval period being probably rather prolonged, as specimens kept under observation for some weeks showed no appreciable growth. The pupae, which are capable of rather active movements if disturbed, are found in the hollowed-out portions of rhizome and stalk-base, and in the intermingled debris. The mature weevil is nocturnal in habit, remaining in the soil during the hours of daylight. It attacks the green portion of the plants, being most destructive to the young fronds, though if it be offered nothing better it will certainly nibble at the harder parts, which it does perhaps during its sojourn below ground. The ravages of this species appear to be strictly confined to hot-house ferns, and although a majority of the genera in the fern-houses have at some time or another been subjected to attack, yet the species of *Davallia*, *Adiantum*, *Todea*, and *Nephrolepis* have endured by far the greatest devastations. *Lastrea*, *Nephridium*, *Polypodium*, and *Asplenium* are also genera which have suffered severely.

## REMEDIES.

With a view to exterminating the insect, fumigating with tobacco was at first tried, but without effect; watering with a solution of Potassium Cyanide, and then washing out with fresh water, was successful in killing the grub only when the solution was of sufficient strength to kill the plant as well. A number of weevils, grubs, and pupae were destroyed by the laborious process of picking the roots clean of all soil, but this was very severe upon the plants. Eventually the houses were fumigated once a month during the night-time, with hydrocyanic acid, likewise an ineffectual method. The plan of steeping the plants in water was then tried, the top of the pot being placed well under the surface; after fifteen minutes of such immersion, all the weevils present in the soil are found to have taken refuge in the stems, where they can be picked off by hand and destroyed. This was found to be the most successful method of dealing with them, and after a year or two a very considerable reduction in the numbers of the insects was effected. Occasional steepings have since then served to keep them in check, and have further diminished their numbers.

## ALLIED FORMS ATTACKING FERNS.

The genus *Syagrius* was defined by Pascoe (3), the type before him being the Australian species *S. fulvitarsis*, from the Richmond River. He regarded it as being allied to the rare genus *Steremnius*

and referred it to the Molytides. Mr. W. W. Froggatt (4) records the appearance of this *S. fulvitarsis* from greenhouses at Sydney, where it damages the leaf-stalks of *Calipteris prolifera*, its habits being apparently similar to those of *S. intrudens*. Mr. Froggatt, however, in the same paper (4) describes a very much more destructive pest, which he terms the Maiden-hair Fern Weevil, publishing, together with his account, Mr. A. M. Lea's description of that species. Mr. Lea is of opinion that it belongs to a genus allied to, but distinct from, *Syagrius*, and terms it *Neosyagrius cordipennis*. This species is remarkably small, a circumstance which enables its grub, which, when full-grown, is only 1½ lines in length, to spend its life eating its way down the delicate leaf-stalks of the Maiden-hair Fern. The tiny Weevil, with short, heart-shaped body, spends the day-time concealed in the earth; during the night-time, it eats the fronds and deposits its eggs on the stems.

As the result of a number of experiments it was found that the best remedy was to place the ferns under water, the beetles being collected and destroyed as they came to the surface. Half an hour is sufficient to drive out the Weevils, but it appears that the ferns improve by being left over-night in lukewarm water, as not only are all the beetles driven out of the soil, but the larvae and pupae are smothered by the water which penetrates into the damaged fronds. If care is taken not to startle them by sudden light or movements, numbers may be taken by shaking the plants over paper during the night time.

In view of the habitat of the above species it seems probable that *Syagrius intrudens* has been introduced into the Botanic Gardens at Dublin from Australia, and it is more than likely that this species or related forms, will at some time claim the attention of fern cultivators elsewhere. Hence the advisability, in most cases, of subjecting newly-acquired plants to a strict quarantine, and of immersing the pots to detect the presence of the Weevil.

It may be mentioned that the grubs and imago of the native genus, *Otiorrhynchus*, are at times found together with those of *S. intrudens*, but the grubs of the latter are readily distinguished by being whiter, and having few hairs upon the body, and a more globular head.

Before proceeding to the details of the larva and pupa, I may remark that very few Weevil larvae appear to have been adequately figured and described. E. Perris (5), in his "Larves de Coléoptères," described in detail, as a Curculionid type, both larva and pupa of *Balaninus elephas;* the description, unfortunately, is not illustrated. The most complete account of a Weevil larva and pupa that I am acquainted with, is that of *Balanogastris kolae* by M. P. Lesne (6).

He lays particular stress upon the distribution of the sensory hairs of the larva and the "styli motorii" of the pupa.

## STRUCTURAL DETAILS.

*Egg* (Pl. vi, fig. 1).—Length, 1.4 mm., smooth, opaque white, cylindrical, with sides parallel, one end more obtusely rounded than the other, twice as long as broad.

*Larva* (Pl. vi, figs. 2-8).—Body a pure white, with yellow-brown head, legless, skin wrinkled, rather elongate, length of largest larvae about 12 mm. when moderately extended. The head is of medium size, strongly chitinised, and decidedly globular. The frons (*f*, fig. 3) carries six characteristically situated sensory hairs, the epicranium about ten (*ep*, fig 3). The sutures (fig. 3) are markedly different from those of *Balaninus elephas* (5) and *Balanogastris kolae* (6), the apex of the frons being very obtuse, and the suture between it and the epicranial plate is on each side, at a little distance from the apex, continued on for some distance (*lat*, fig. 3) parallel to the median epicranial suture. The antennae (*a*, fig. 4) are minute, and can be made out just above and between the ginglymus (*g*, fig. 4) and the insertion of the flexor of the mandible (*in*, fig. 4) there are not more than two segments apparent. Just above and to the outside of the antenna, on each side there is a small darkly pigmented ocellus (*o*, fig. 4). Antennae and eye-spots are similar in *Balaninus elephas* and *Balanogastris kolae*, but according to Lesne the proximal segment of antenna is only the articular membrane. The clypeus (*c*, figs. 3, 4) is distinctly articulated with the frons, and is rectangular, tapering slightly. It is small, overlaying a portion of the mandibles, and bearing no setae. In *Balanogastris kolae* the clypeus bears three pairs of sensory hairs. The labrum (side view *l*, fig. 4) is about twice as broad as long, and is rounded off distally. The anterior surface bears six sensory hairs, and the edge is furnished with ten short bristles, the two central of which are the stoutest.

The dark-coloured mandibles (figs. 4, 6) are very strong, tetrahedral in shape, and have the condyle (*co*), ginglymus (*g*), and area of insertion of the extensor muscle (*in*) prominently developed. The apex of each mandible is divided into two short teeth, and the anterior surface bears a single hair. The tendon of insertion of the flexor muscle (*fl*) is very broad, and lies in an antero-posterior plane. The maxillae (figs. 5, 7) are free from the head skeleton, and are about a third longer than the mandible. Each possesses a chitinized cardo (*cr*) and stipes (*st*), the latter bearing three delicate setae. The lacinia (*la*) is a simple process bearing at its apex and along the edge about fifteen short,

strong hairs. The palp (*pl*) is represented by a two-segmented process, which is just a little longer than the lacinia. The labium (figs. 5, 8) is clearly posterior to the maxillae, its basal portions overlapping those parts. The supporting gular region (*gl*, fig. 5) consists of soft fleshy lobes, which carry some half-a-dozen delicate hairs, and converge somewhat acutely to the apex of the labium, which is encircled by a pale brown, chitinized, cuticular band (*x*). Beyond this plate (*x*) the extremity carries a pair of two-segmented papillae (*lp*), no doubt the labial palps. On the posterior aspect of the tip, slightly internal to the palps, are a proximal pair of fine hairs and a distal pair of shorter stouter ones.

The more important folds of the cylindrical body show (fig. 2) more particularly on the ventral region, that there are twelve body segments represented. The folds of the individual segments do not appear to be so definite as those described by Lesne. The larvae is legless. The lowest of the lateral folds being, perhaps, to some extent, of service as pro-legs; in the abdominal regions these folds carry two, and in the thoracic region a few more, setae. More decided vestiges of the legs appear to exist in *Balanogastris kolae*. There is a decided pronotal plate (*pr*), which is lightly-tinted with brown; it carries a couple of hairs. The general surface of the body is furnished with a very few small, scattered setae; however, segments eleven and twelve each carry some half-a-dozen characteristically placed elongate hairs. "Spinules tégumentaires," such as are described in *Balanogastris kolae*, are absent from the integument. Spiracles, which are marked by a faint brownness of the cuticle, are present upon the first thoracic and on the first eight abdominal segments.

*Pupa* (Pl. vii, figs. 1-2).—Length variable, averaging 6 mm. in examples met with. White. Surface conspicuously spiny, with numerous short setae, each borne upon a soft conical papilla; these, termed "styli motorii," by Lesne, are most probably locomotive in function. The head is smooth, with the exception of seven pairs of setiferous papillae, which are situated at intervals, on each side of the middle line, along the forehead (*fr*) and rostrum (*r*). The proportions of the antenna are somewhat different from those of mature insect, the scape being relatively very much shorter, and coming off from the middle of the rostrum. The prothorax (*p*) carries two pairs of centrally situated setae; seven or eight of smaller size extending over the lateral surface on each side. The mesothorax (*m*) bears across its dorsal surface some half-dozen setae. The elytra arise laterally, taper to a point, and have their surface marked by ten or so longitudinal grooves. The elytra are embraced between the second and third thoracic legs of

each side. At the femoro-tibial articulation, there are on each of the legs a pair of setae. The metathoracic segment is indicated by a slight setiferous prominence, the abdominal segments being more decidedly ridged off. The first seven of these latter segments bear dorsally situated rows of eight, or at most ten, setae; the eighth carries but two. In *Balanogastris kolae* the hairs are everywhere distributed in accordance with the same plan, but are fewer in number. The anal segment (not regarded as separate segment by Lesne) has a pair of small posteriorly directed processes (*ap*), which are each furnished with three minute hairs and terminated by a single, curved, chitinous bristle. A pair of similar processes are present in *Balaninus elephas* and *Balanogastris kolae*. The spiracles which I have observed are:—A pair on the metathorax anterior to the very small wing rudiments, and a pair upon each of the eight succeeding segments, in front of and slightly below the most laterally situated of the dorsal setae.

*Imago* (Pl. vii, figs. 3, 4, 5).—To accompany the figures of the adult Weevil, I append below Mr. F. P. Pascoe's (3) definition of the genus, and Mr. C. O. Waterhouse's (1) diagnosis of this species. I may add, that the short, light-brown pubescence, very conspicuous on actual specimens, does not appear so distinctly in figures 3 and 4. On removing the elytra the dorsal abdominal tergites are seen to be exceptionally soft, the wings appearing as minute scales. In some specimens I found the elytra were united, in others free.

### **Genus Syagrius,** Pascoe.

"*Rostrum* modice elongatum, arcuatum; *scrobes* praemedianae, obliquae, infra rostrum currentes. *Oculi* ovales, grosse granulati. *Scapus* oculum haud attingens; *funiculus*, 7-articulatus articulis extus gradatim crassioribus. *Prothorax* lateribus rotundatus, basi rectus; lobis ocularibus nullis. *Scutellum* invisum. *Elytra* cylindrica, prothorace haud latiora. *Coxae* posticae rotundatae; *femora* mutica, antica majora; *tibiae* flexuosae, muticae; *tarsi* breves, latiusculi; *unguiculi* liberi. *Abdomen* segmentis duobus basalibus ampliatis, sutura prima distincta."

### **Syagrius Intrudens,** Waterhouse.

"Elongatus, crassus, subparallelus, piceo-niger, parum nitidus, rugosus; antennis tarsique piceis. Long. 7-10 mm."

"Rostrum gently arcuate, thick, with a fine median smooth line, and with a groove on each side above the antennal groove; the apex shining and finely punctured. Forehead rugosely punctured, with a well-marked impression in the middle. Thorax with its broadest part

in front of the middle, a trifle narrower at the anterior angles than at the posterior; the sides arcuate; the base exactly fitting the base of the elytra, but a triflé narrower. The surface very uneven, consisting of closely packed irregular obtuse tubercles, some of which are shining. The interspaces with very short brownish pubescence. Elytra very convex, humped up at the suture, with a slight constriction at the base, gradually widening from this to the apical declivity, where they are as wide as the widest part of tht thorax. Apical declivity almost vertical. The region of the scutellum and some irregular, rather oblique, vermiculate impressions dull black. The rest of the surface covered with very irregular more or less confluent tubercles, which are themselves ornamented with very small shining tubercles. Near the suture, just at the apical declivity, there are two tubercles, which are rather more prominent than the others; these and some of the others have more or less brownish hair on them. There are also some of these short brown hairs just within the humeral angle. At the sides there are two or three rows of elongate deep foveae.

"The punctuation of the basal portion of the rostrum varies very much. Some specimens have it closely and rugosely punctured; in others the punctures are separated and the surface is shining. This difference is no doubt sexual. This species resembles *S. fulvitarsis*, Pascoe, but the rostrum is less strongly curved, and the tubercles on the dorsal surface of the thorax and elytra are much more numerous. In *S. fulvitarsis* the dull black surface is greater than that occupied by the tubercles; in *S. intrudens* the reverse is the case."

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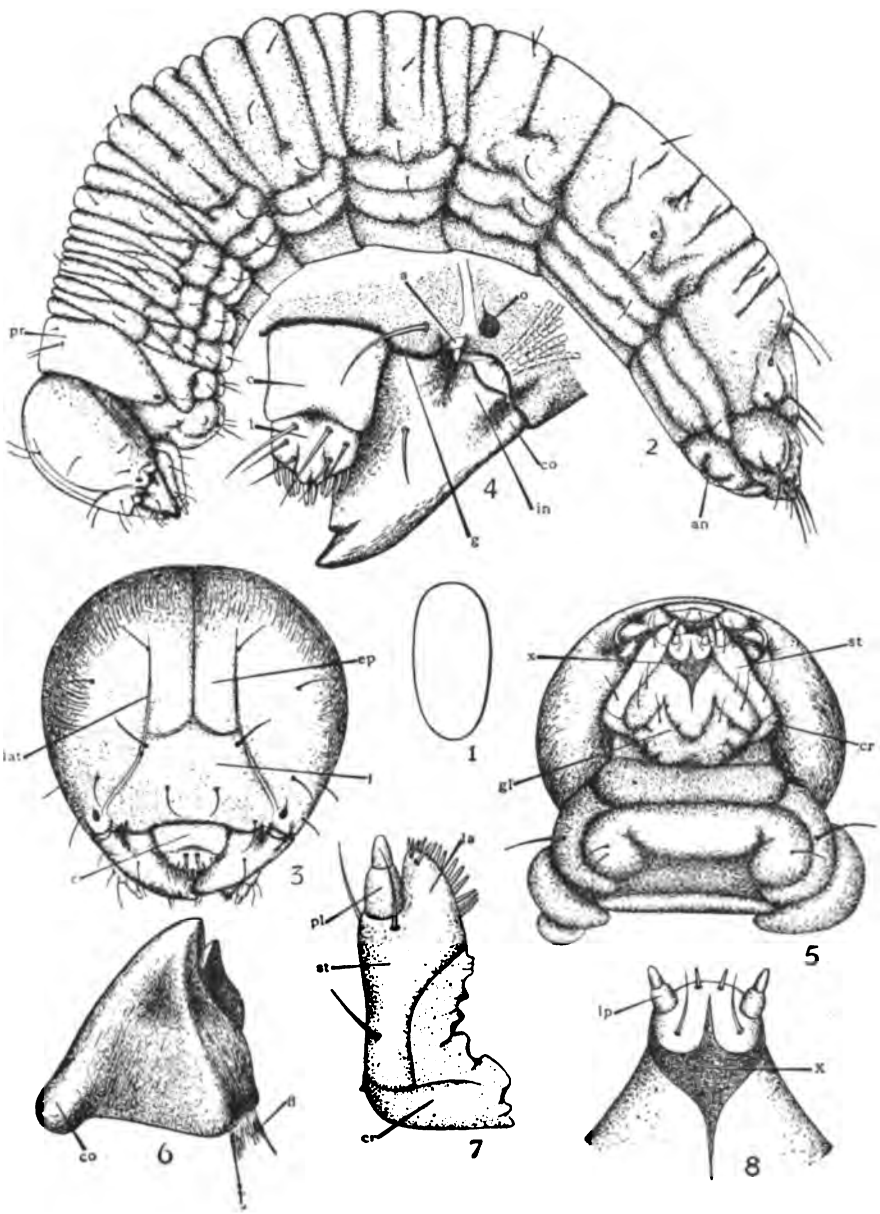
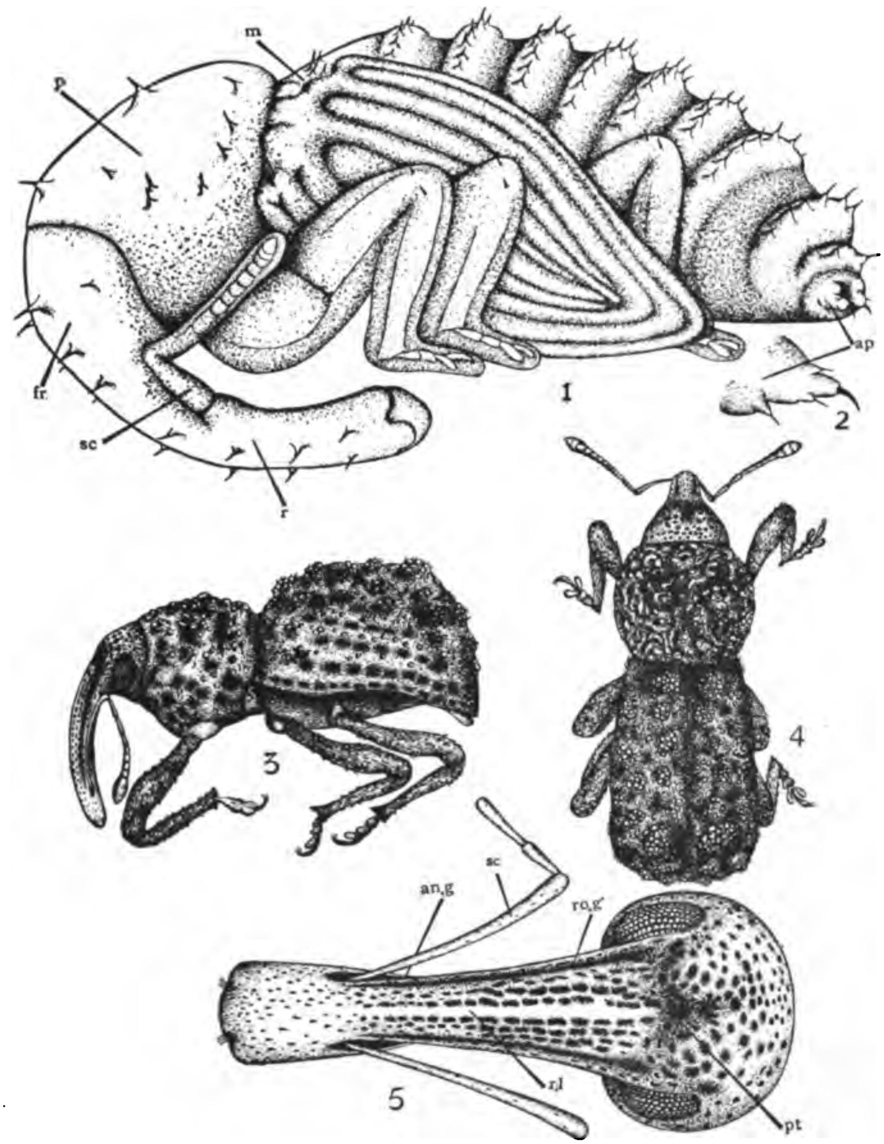
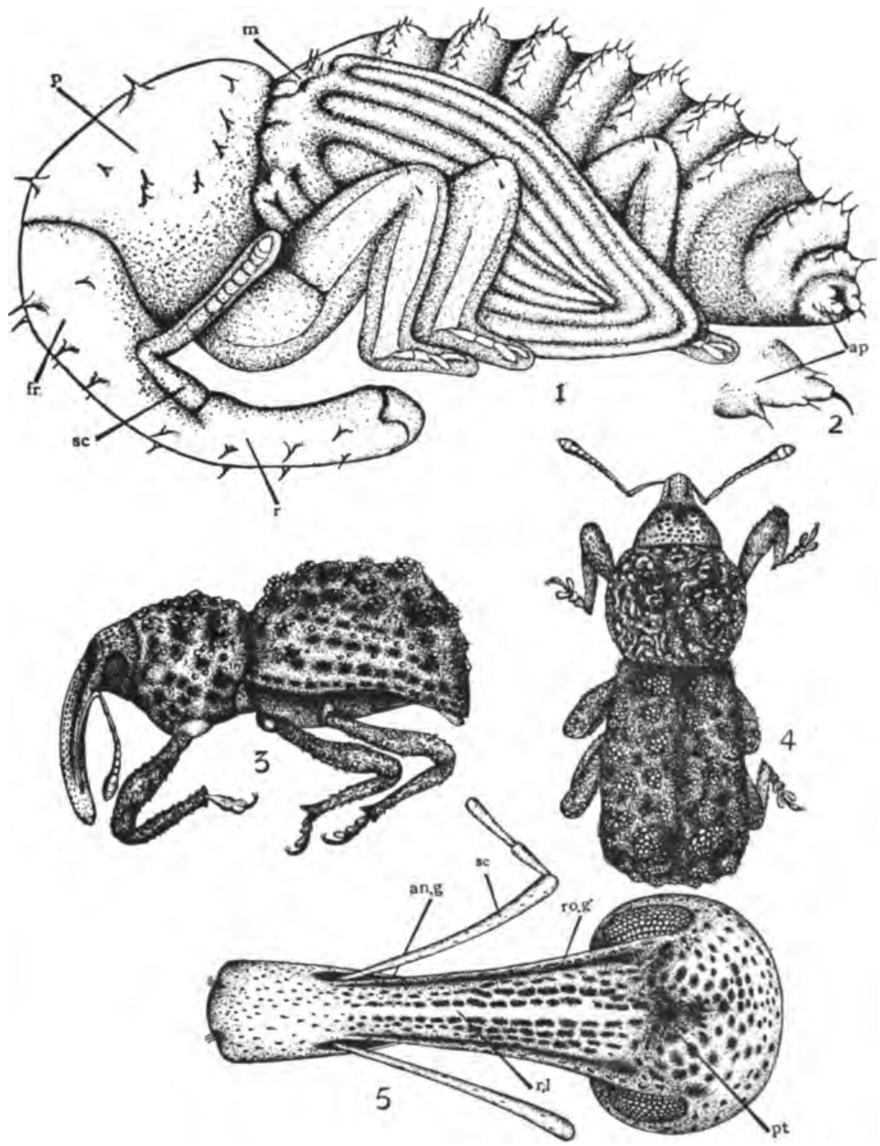



SYAGRIUS INTRUDENS, Waterh.




SYAGRIUS INTRUDENS, Waterh.




SYAGRIUS INTRUDENS, Waterh.

## DESCRIPTION OF PLATES VI AND VII.

Illustrating Mr. Joseph Mangan's paper on "The Life-History of *Syagrius intrudens*," Waterh.

### Plate VI.

Fig. 1.—Egg of *Syagrius intrudens*. × 15.
Fig. 2.—Larva of *S. intrudens* viewed from the side. × 19.
Fig. 3.—Head of same viewed from in front. × 33.
Fig. 4.—Labrum and mandible viewed rather laterally: also showing the left antenna and ocellus. × 78.
Fig. 5.—Head and mouth-parts viewed from below, with the head pressed slightly upwards. × 33.
Fig. 6.—Right mandible viewed from behind. × 78.
Fig. 7.—Right maxilla do. do.
Fig. 8.—Labium do. do.

*a*, antenna; *an*, anus; *c*, clypeus; *co*, condyle; *cr*, cardo; *ep*, epicranium; *f*, frons; *fl*, tendon of insertion of flexor muscle of the mandible; *g*, ginglymus; *gl*, gular lobes; *in*, insertion of extensor muscle of the mandible; *l*, labrum; *la*, lacinia; *lat*, lateral continuation of epicranial suture; *lp*, labial palp; *o*, ocellus or eye spot; *pl*, maxillary palp; *pr*, pronotal plate; *st*, stipes; *x*, sclerite on posterior surface of labium.

### Plate VII.

Fig. 1.—Pupa of *S. intrudens* viewed from the side. × 21.
Fig. 2.—Left process of anal segment of pupa. × 53.
Fig. 3.—Imago of *S. intrudens* viewed from the side. × 8.
Fig. 4.—Dorsal view of same. × 8.
Fig. 5.—Head and rostrum of same viewed from in front. × 21.

*an.g*, antennal groove; *ap*, process of anal segment; *fr*, forehead; *m*, mesothorax; *p*, prothorax; *pt*, pit-like depression on forehead; *r*, rostrum of pupa; *n.l*, smooth median line on rostrum; *ro.g*, superior rostral groove; *sc*, scape of antenna.

## REVIEWS.

**Connold, E. T.**—British Oak Galls. Pp. xviii + 169, 68 plts. and 17 text figs. London: Adlard & Son, 1908. Price net.

There is so much excellent foreign literature upon Galls and Gall-makers that we opened Mr. Connold's book with great expectations, only to have our hopes disappointed. At times we have had occasion to refer to the beautifully illustrated and lucidly written works of Keiffer, Houard, Trotter, Giraud, Perez, and other Continental writers, and possibly after the excellent descriptions that are to be found in such works, we came expecting too much. However, the fact remains, that the information given in this book, like that in the author's previous one on "British Vegetable Galls," is of the scantiest.

There is an abundant literature on Oak Galls and their inhabitants, and we are sorry that the author has not made greater use of the same.

The half-tone illustrations are all excellent, indeed quite equal to any we have seen of galls, and the objects have been selected with care and discrimination. Such an admirable series of figures go a long way to redeem many shortcomings in this book, and will be a source of help to all who are interested in British Oak Galls.

W. E. C.

**Darwin, Charles.**—Insectivorous Plants. Revised by Francis Darwin. Pp. xiv + 377, 30 illustrations. London: John Murray, 1908. Price 2s. 6d. net.

The issue of a popular edition of Darwin's fascinating work on Insectivorous Plants will be welcomed by a large body of naturalists, whilst it places within the reach of the rising generation all but one of Darwin's great works published by Mr. John Murray.

Since it was first published, now thirty-three years ago, much valuable work has been done; great strides have been made in the study of vegetable physiology, and experimental botany, but, as with all the author's works, time does not lesson their interest.

All who take an interest in plant life will read the book with a keen appetite, whilst to naturalists generally its perusal is still a part of their education.

At a time when Natural History Societies are stocking their book-shelves with much illustrated literature of an ephemeral nature, we would strongly advise the addition of the Popular edition of Darwin's works, which Mr. Murray has placed before the public in such an admirable style.

W. E. C.

**Fisher, W. P.**—Forest Utilization. Vol. V. Schlich's Manual of Forestry. Second Edition. Pp. xxii + 840, 5 plts. and 402 text figs. London: Bradbury, Agnew & Co., Ltd., 1908. Price 12s. net.

All students of forestry will welcome the second edition of Professor Fisher's valuable work on Forest Utilization. Since its publication in 1896, it has been regarded by all competent authorities as the leading and most comprehensive work on the subject.

Founded upon a translation of Gayer's "Die Forstbenutzung," which like most great works had become such whilst passing through a series of editions, nine in all, dating from 1863 to 1903, the author has made numerous additions in the form of notes, and has generally brought the subject up-to-date, so that it now remains the standard work in the English language on this important subject, and cannot fail but prove of great use and value to all students and practical foresters.

With the renewed interest which is now being taken in forestry in this country, we can only hope that the second edition will be even more successful than the first, of which 1,500 copies were issued in 1896.

W. E. C.

**Janet, Charles.**—Anatomie du Corselet et Histolyse des Muscles Vibrateurs, apres le Vol Nuptial chez la Reine de la Fourmi *Lasius niger*. Pp. 149 + 20, 13 plts. and 45 text figs. Limoges: Ducourtieux et Gout., 1908.

Of all the memoirs of M. Janet's great work "Études sur les Fourmis, les Guêpes et les Abeilles," of which this is the twenty-sixth, none are more beautifully produced or greater in interest.

Like all this author's work, it is as near perfection as unwearied and patient research can make it, indeed it is not too much to say that amongst the many magnificent works on insects—systematic and anatomical—it is not surpassed for accuracy of detail and faithful minutiae.

The work lends itself to a division into two parts, the first treating of the pairing, nest founding and nuptial flight; and the second and major portion of the work of the histolysis of the flight-muscles and the detailed structure of the thoracic exoskeleton.

The degeneration of the great flight-muscles, functional during the life of the queen-ant for only a few hours, the enrichment of the vascular system by their broken down constituents, and the consequent supply of food necessary for the production of a large number of eggs and the nourishment of the larvae, is described in great histological detail with a full appreciation of its vast physiological import.

No student of insect anatomy or insect bionomics can afford to overlook this magnificent work, which is characterised by wonderful detail and accuracy, beautiful illustrations, and a lucidity to be envied.

W. E. C.

**Johnstone, James.**—Conditions of Life in the Sea. Pp. xiv + 332, 1 plt. and 31 figs. Cambridge: The University Press, 1908. Price 9s. net.

There is at present no adequate summary in English, the author informs us, of the main results of modern quantitative marine biological investigations, we therefore welcome Mr. Johnstone's work as an admirable and valuable piece of work.

The book is divided into three parts, the first supplying a general account of the main facts of oceanography; part ii. deals with the methods and results of quantitative marine biological research; and part iii. with the general conditions of life in the sea.

To condense into three hundred pages an account of these three sections is no easy task, much of the matter upon which they are founded is of a highly technical nature, and such as requires the most careful discrimination, and admittedly imperfect and incomplete as are the investigations, a fact freely admitted by the author, they nevertheless have been handled with such skill as to form a most fascinating whole.

The distribution of the plankton, the productivity of the sea, the conditions of life and the bacteria of the sea, are chapters specially commendable, and full of thoughtful work that must appeal to all who take an intelligent interest in modern biological development.

Mr. Johnstone has been at some pains to bring the information now given up-to-date, whilst a short bibliography, together with numerous references in foot-notes, will enable the reader to at once tap the original sources of information.

Enough has been said to show that this is a work of considerable interest, and cannot fail to appeal to a large number of readers.

W. E. C.

**Pearson, J.**—L. M. B. C. Memoirs. XVI. Cancer. Pp. viii + 209. Plts. i-xiii and 12 figs. London: Williams & Norgate, 1908. Price 6s. 6d.

The subject of this memoir, *Cancer pagurus*, the edible crab of this country, is an animal of great economic importance and zoological interest.

So far as the morphology is concerned the author has given an excellent account of both the external and internal structure, but we should have welcomed more fuller details under the section Economics and Bionomics.

Why the figures illustrating this valuable series of memoirs should be reproduced in a sooty-coloured ink instead of a deep black, and on tinted instead of white paper, is a mystery unknown to us, but whatever the cause it greatly depreciates their value.

W. E. C.

**Poulton, E. B.**—Essays on Evolution, 1889-1907. Pp. xlviii + 480, 1 plt. and 7 text figs. Oxford: The Clarendon Press, 1908. Price 12s. net.

The eleven essays included in this volume deal mainly with the subject of mimicry, to the literature of which they are a valuable addition.

The introduction will be read with considerable interest, for Professor Poulton enters a strongly worded protest against the narrowness and prejudice apparent in the earlier works of Bateson on Variation, and has some equally pertinent remarks on the "grotesque exaggeration" of other Mendelians. He contends that the conclusions supported in the present volume are inconsistent with a theory of evolution by Mutation, inconsistent with the views often expressed by Mendelians, but not inconsistent with the discoveries of Mendel himself.

Excepting the first, the Introduction, and the seventh essay, all have been published some time, but the author has revised and modified them since, and made many additions to the text and footnotes.

In much that Professor Poulton regards as Mimicry we are unable to follow him, but most biologists will welcome his trenchant criticism of Mendelism.

It has been evident for some time past that there was gradually creeping into Mendelian literature an "amount of dogmatism concerning work which the writer was evidently imperfectly acquainted" with, and that assumptions were being made on the slenderest evidence. Professor Poulton thinks that the Mendelian "is to some extent paralysed by his own work," but whether this be so or not, it is no excuse for appropriating under the name of Mendel the results of Weissman, or the contemptuous depreciation of the work of others.

The author strikes boldly, but fairly throughout, and we welcome his outspoken defence and criticism.

The work concludes with a most useful and carefully compiled analytical index, extending over eighty printed pages.

W. E. C.

**Shipley, A. E.**—Pearls and Parasites. Pp. xv + 232, 10 illustrations. London: John Murray, 1908. Price 7s. 6d.

Since Huxley published his justly popular "Essays and Addresses," there have been few scientific essayists who have commanded more than passing attention. Some are curt and uninteresting, others verbose and wearisome.

The author of the interesting volume before us seems to have hit the happy medium, and whether writing on "British Sea-Fisheries," "Malaria," or of the claims of the University of and in which he is so distinguished an ornament and worker, there is the same graceful charm and lucidity, full of freshness and keen interest.

Most of the nine essays we have had the pleasure of reading before, but in perusing them for a second time they have lost none of their original interest, and we welcome them in book form for future reference.

Few men are more competent than Mr. Shipley to pronounce an opinion on such subjects as our sea-fisheries, malaria, parasitic diseases due to flies, pearl fisheries, and the financial needs of Cambridge University, and all who are interested, even in the slightest degree, in these subjects, will read this work with both pleasure and profit.

W. E. C.

**Thomson, J. Arthur.**—Heredity. Pp. xvi + 605, 49 illustrations. London: John Murray, 1908. Price 9s. net.

Amidst the voluminous, and often very dogmatic, literature dealing with the important subject of Heredity, it is refreshing to find a calm, tolerant, lucid, and comprehensive work like the one before us. It is not too much to say that the most outstanding feature is the fair and kindly manner in which all views are presented.

We have just stated that the work is lucid and comprehensive, and on this account alone far surpasses any book we know of for the beginner, or he would have marshalled before him the facts and fancies upon which our ideas of heredity are founded.

Whilst there are many controversial matters on which we strongly differ from Prof. Thomson's view, we put these aside for the present, in acknowledgment of the admirable survey he has given us of a most complicated subject in a manner uncommon to works on such subjects.

If the book has a fault, it is the insufficient critical spirit, but when one reflects that two-thirds of the so-called scientific criticism of the present day is such childish and puerile fault finding, we are glad to find only such criticism as "is the ripe fruit of combined intellectual insight and long experience," and not the petty jealousies unworthy of seekers after truth.

The book is beautifully illustrated, contains an excellent bibliography and subject index to the same, and a full index.

W. E. C.

## CURRENT LITERATURE.

### I.—General Subject.

**Burgess, A. F.**—Description of new devices for rearing Insects. Journ. Econ. Entom., 1908, vol. i, pp. 267-269, plts. 3, 4.

### II.—Anatomy, Physiology, and Development.

**Gahan, C. J.**—On the Larvae of *Trictenotoma childreni*, Gray, *Melittomma insulare*, Fairmaire, and *Dascillus cervinus*, Linn. Trans. Entom. Soc. Lond., 1908, pp. 275-282, plt. vi.

**Imms, A. D.**—On the Larval and Pupal Stages of *Anopheles maculipennis*, Meigen. Parasitology, 1908, vol. i, pp. 103-133, plts. ix, x.

**Paoli, G.**—Intorno all'organo del Graber nelle larve di Ditteri Tabanidi. Redia, 1907, vol. iv, pp. 247-258, 6 figs.

**Vickery, R. A.**—A Cómparative Study of the external anatomy of Plant Lice. 12th Rpt. State Entom. St. Anthony Park, Minn., 1908, pp. 1-16, 5 figs.

**Wesché, W.**—Notes on the value of the genitalia of insects as guides in Phylogeny. Trans. Entom. Soc. Lond., 1908, pp. 297-305.

### III.—General and Systematic Biology, and Geographical Distribution.

**Berlese, Antonio.**—Considerazioni sui rapporti tra piante, loro insetti nemici e cause nemiche di queste. Redia, 1907, vol. iv, pp. 198-246.

**Berlese, Antonio.**—Istruzioni pratiche per coloro che vogliono rinnovare le esperienze do lotta contro la mosca delle olive col metodo dachicida. Ibid., pp. 193-197.

**Berlese, A., Del Guercio, G., Paoli, G.**—Osservazioni sopra un recente scritto relativo ad insetti nocivi all'Olivo. Ibid., pp. 259-328.

**Börner, C.**—Eine monografische Studie über die Chermiden. Arb. Biol. Anstalt f. Land-u. Forstw., Berlin, 1908, Bd. vi, Heft. 2, pp. 239, 3 tav. e 101 fign.

**Buffa, P.**—Alcune notizie anatomiche sui Tisanotteri Tubuliferi. Redia, 1907, vol. iv, pp. 369-381, 17 figs.

**Buffa, P.**—Esame della Raccolta di Tisanotteri italiani esistente nel Museo Civico di Storia Naturale di Genova. Redia, 1907, vol. iv, pp. 382-391, 5 figs.

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**Cooper, W. F., and Robinson, L. E.**—On six new species of *Ixodidae,* including a second species of the new genus *Rhipicentor,* N. & W. Proc. Camb. Phil. Soc., 1907, vol. xiv, pp. 457-470, 24 figs.

**Fuschini, C.**—Contributo allo studio della *Philloxera quercus,* Boyer. Redia, 1907, vol. iv, pp. 360-368.

**Green, E. E.**—Remarks on Indian Scale Insects (Coccidae) Pt. III. Mem. Dept. Agric. India, Entom. Ser., 1908, vol. ii, no. 2, pp. 15-46, plts. ii-iv.

Describes 1 new genus, 18 new species, and 1 new variety. There is a useful Catalogue of Indian Coccidae of 102 species.

**Lebour, Marie V.**—Fish Trematodes of the Northumberland Coast. Northumberland Sea Fisheries Comm. Rpt. for 1907, 1908, pp. 23-67, plts. i-v.

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**Marlatt, C. L.**—New species of Diaspine Scale Insects. Ibid., Tech. Ser. No. 16, pt. ii, pp. 11-32, plts. i-ix.

The author describes 17 new species, four of which are apparently native to the American Continent, and the remainder foreign. All are of potential economic importance, as. indicated by the place of origin and the host plants.

It is most unfortunate that none of the species are figured, beyond some very indistinct figures from photo-micrographs of the anal plates.

**Newell, W.**—Two interesting Inquilines occurring in the nests of the Argentine Ant. Journ. Econ. Entom., 1908, vol. i, pp. 262-265.

**Nuttall, G. H. F., and Warburton, C.**—On a new genus of *Ixodoidea,* together with a description of eleven new species of ticks. Proc. Camb. Phil. Soc., 1907, vol. xiv, pp. 392-416, 45 figs.

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**Sanderson, E. D.**—The Influence of Minimum Temperatures in limiting the Northern Distribution of Insects. Journ. Econ. Entom., 1908, vol. i, pp. 245-262, 7 maps.

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III.—Agriculture and Horticulture.

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**Chittenden, F. H.**—The Asparagus Beetles. U.S. Dept. Agric., Bur. of Entom., Circ. No. 102, 1908, pp. 1-12, figs. 1-6.

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**Collinge, Walter E.**—The Possibility and Danger of the Introduction of the San José scale into Great Britain. Proc. Assoc. Econ. Biol., 1908, vol. i, pp. 171-178.

**Coudon, F. D.**—A Gall-Maker of the Family *Agromyzidae.* (*Agromyza tiliae,* n.sp.). Proc. Entom. Soc. Washington, 1908, vol. ix, pp. 1-4, 1 fig.

**Del Guercio, G.**—Notizie intorno a due nemici nuovi e ad un noto nemico dell 'olivo mal conoscinto, con un cenno sui rapporti di uno di essi con i microsporidi. Redia, 1907, vol. iv, pp. 334-359, 14 figs.

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**Güssow, H. T.**—The Predisposition of Plants to Parasitic Diseases. Proc. Assoc. Econ. Biol., 1908, vol. i, pp. 158-170.

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The author states in conclusion—"The question here presented is a vital one for the weevil infected area. It demands not merely acquiescence, but action. The accuracy of the facts presented cannot be questioned, but each man must decide for himself as to the correctness of the conclusions. To us it appears that this statement does abundantly justify the broad, general conclusion that the destruction of stalks by some effective method and as long as may be possible before the normal time for weevils to enter hibernation constitutes the most effective method now known of reducing the severity of the weevil attack upon the following crop, and that it therefore deserves general recognition and adoption as the last step in the treatment of each season's crop, and essentially the first step also in the production of a crop with the minimum weevil injury during the following season."

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**Lefroy, H. M.**—Imported Insect Pests. Agric. Journ. India, 1908, vol. iii, pp. 237-244.

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**Mackenzie, M., and Lefroy, H. M.**—The Sugarcane Borers of Behar. Agric. Journ. India, 1908, vol. iii, pp. 104-124, plts. xx-xxii.

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**Newell, W., and Treherne, R. C.**—A new predaceous enemy of the Cotton Boll Weevil. Ibid., pp. 244.

A Carabid known as *Evarthrus sodalis,* Lec.

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**Patel, C. U.**—Katra (Hairy Caterpillars) in Gujarat. Agric. Journ. India, 1908, vol. iii, pp. 152-160.

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**Sanderson, E. D.**—Caterpillars injuring Apple foliage in late Summer. New Hampshire Agric. Exp. Stat., 1908, Bull. 139, pp. 207-228, 1-13.

**Stockdale, F. A.**—Root Disease of Sugar Cane. W.I. Bull., 1908, vol. ix, pp. 103-116.

This disease in the West Indies is chiefly caused by *Marasmius sacchari,* but it is thought that other fungi may be the cause of some of the damage noticed.

The symptoms, distribution, and spread of the disease are discussed together with remedial measures.

**Stockdale, F. A.**—Fungus Diseases of Cacao and Sanitation of Cacao Orchards. Ibid, pp. 166-189.

## V.—Forestry.

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## VII.—Medicine.

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**Jackson, D. D.**—Pollution of New York Harbor as a menace to health by the dissemination of Intestinal Diseases through the agency of the Common House Fly. Merchants' Assoc. New York, 1908, pp. 1-22, 7 plts.

A very valuable report showing a condition of sanitation and an apathy on the part of the Authorities that one would not have conceived possible in any civilized and educated community.

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## VIII.—Animal Diseases.

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**Borrel, A.**—Lympho-sarcome du chien. C. R. Acad. Sci. Paris, 1907, T. 144, pp. 344, 345.

**Cameron, S. S.**—Parasitic Skin Diseases. Journ. Dept. Agric. Victoria, 1908, vol. vi, pp. 444-448.

**Donitz, W.**—Die Texasfieberzecke *Boophilus annulatus*, und das Ixodinengenus *Margaropus*. Sitz.-Ber. Gesell. nat. Freunde Berlin, 1907, pp. 187-192.

**Gates, B. N.**—Bee Diseases in Massachusetts. U.S. Dept. Agric., Bur. of Entom., Bull. No. 75, Pt. III, 1908, pp. 1-32, plt. iv.

**Saigol, R. O.**—Experiments on "Rat Extermination." Indian Med. Gaz., 1908, pp. 254-256.

As a result of experiments made with various much advertised preparations the writer concludes: "Although hope had been extended from many quarters that rat extermination would be practicable by employing some micro-organism which would not only produce a disease in the animals directly experimented upon, but an infectious fatal disease among the rat population as a whole through these diseased rats being let loose, this has not been borne out by the experiments given above.

Supposing an organism is capable of producing an infectious, communicable disease among the rodents, it must do so through the infection being carried about in one or more of the following ways:—(1) by discharges; (2) by suctorial insects; and (3) by food (eating carcases).

That none of these means was potent enough in the case of any of the bacillary preparations experimented upon by me, is evident from the results. Further, no organism could be more virulent for rodents than the bacillus pestis, and yet rodents have not only not been decreased to any appreciable extent, but continue in such large numbers as to require special means to get rid of them.

The position therefore remains as it was before, and further experience will teach us what are the ways in which rats can be best got rid of, or whether measures ensuring the exclusion of free rats coming in contact with human beings would not be more beneficial as against rat extermination to which, practically, there seems no end."

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**Theiler, A.**—Experiments with English and South African Redwater. Transv. Agric. Journ., 1908, vol. vi, pp. 534-543.

**First Report of the Select Committee on East Coast Fever.** Pp. xxxiv + 86 + v. Cape Town: 1908.

Stock-owners and veterinarians will welcome this First Report, for it places in their hands an authoritative statement on a disease which we are informed causes the loss of 95 per cent. of the cattle attacked.

The disease is spread by five species of ticks of the genus *Rhipicephalus*, and so far as is at present known this is the only means of communicating the disease from one animal to another.

The evidence of Messrs. P. J. du Toit, J. D. Borthwick, C. P. Lounsbury, C. E. Tod, and C. J. Levey is given, and contains much valuable information.

THE

# JOURNAL OF ECONOMIC BIOLOGY.

## PRIORITY AND PRACTICAL ENTOMOLOGY.

By

H. MAXWELL-LEFROY, M.A., F.E.S.,

*Entomologist, Imperial Department of Agriculture for India*

In the Address of the President of the Entomological Society of London, at the Annual Meeting for 1907, the following sentence occurs: "For the last fifty years, names have been constantly changed, and there does not seem to be any immediate prospect of settlement." The paragraph in which this occurs (Proc. Ent. Soc., 1907, pt. v., p. cv.) deals with the question of priority in the names of insects. To a purist in nomenclature, who devotes time to finding the original descriptions of the oldest systematists' species, the correctness of the name to be applied to an insect is a matter of vital importance; this importance is purely academic and bears the same relation to practical entomology, that the variation in nomenclature of geologic strata does to the working prospector or mining surveyor.

There is a very large number of practical working entomologists who are engaged in dealing with insects as pests or as sources of benefit to mankind; these work over the whole globe, most in places far from the academic centres of the world. All correlation in work is based upon accurate diagnoses of insects, and it is all-important to them not only to correctly place and class their insects *on an uniform system applicable to all*, but to *use the same names throughout*, so that one working entomologist in Borneo say, reading the last bulletin on the "American Bollworm" from the United States, may know absolutely whether that insect is identical with any one of those he is familiar with, as it probably is.

I take this as a specific instance; we all knew the American bollworm as *Heliothis armigera;* there is a great literature on it, some extremely valuable. Quite lately, the British Museum issued part of a "Catalogue of Lepidoptera Phalaenae," a monumental work which deserves the gratitude of all entomologists. In this work, issued from

our National Museum, we find our old friend called *Chloridea armigera* in the text, but a few lines in the Appendix call it "*Chloridea obsoleta.*" I would ask who is the better for this change; could not the author have stated that the specific name should, on strict priority, be *obsoleta;* could he not arbitrarily have used the generic name *Heliothis* to cover this group simply on the ground of its constant use during the last century, while stating that *Chloridea* was correct; it is no more an arbitrary thing to do than to state that he can identify this species with the species *obsoleta* of an older publication with which probably few systematists even will agree. Then think of the boundless confusion caused; we have all the old literature of economic importance under "*Heliothis armigera*"; we have now *Heliothis obsoleta*, *Heliothis armigera*, *Chloridea obsoleta*, *Chloridea armigera*. We are making nomenclature an end and not a means, and the level of the Science is sinking below that of stamp collecting. It may be said, why use the British Museum's Catalogue; to economic entomologists there is not time to go into these questions of priority except in so far as they affect literature; an authoritative catalogue, such as that of the British Museum should be, would naturally be the standard of an economic entomologist, who must work from the catalogues of systematists. If these catalogues are not authoritative, what is the use of them?

I have quoted at present one glaring instance. Their number is legion; in the Coccids, for instance, *Lecanium*, *Mytilaspis*, *Dactylopius*, *Coccus*, represented very clear groups recognisable at sight; but they have become *Coccus*, *Lepidosoaphes*, *Pseudococcus*, and *Dactylopius* respectively (to a large number, but not to all authors) on the ground solely of Mrs. Fernald's discoveries in priority; the poor student of *Coccidae* must learn these before he can benefit from both Nineteenth and Twentieth century authors, and in a recent Memoir of this Department, Mr. Green has to state that he maintains the old nomenclature and give the equivalents. This is a case as flagrant as any, since the *Coccidae* are notoriously important and since these generic names meant something definite to the student of economic entomology.

One may reasonably advance the view that the published work on the biology and economics of insects was just as important as the first or the second description, and the fact that a name has in economic literature represented a definite insect for half a century should out-weigh all considerations of academic priority. Yet it is perfectly clear that this view is not acted upon by even so practical a Department as that of the United States, which, in Bulletin 53, listing the economic-

ally important insects exhibited, have, in over thirty instances, to say "formerly known as ——— ———"; this is a catalogue designed for the public, not for the technical reader. If one wishes to identify *Heliothis armigera*, *i.e.*, to be able to apply to it a name by which it can be recognised by others in other countries, one does not delve in the old literature; one looks up whatever manual there is and uses that, with a reference, if necessary, to that manual as containing a description whereby the two workers may check their insects. But with the present arbitrary changes, due to priority, made on the authority of a single author, one must have the latest literature, one must give a list of synonyms, and in all our reference works (*e.g.*, Zoological Record) it will not be sufficient to refer to an insect by one name, but by several, as thus:—*Chloridea* (*Heliothis*) *obsoleta*, F. (*armigera*, F.). I would bring up also other notable instances; we all know the shorthorned grasshoppers and locusts as *Acridiidae*, the longhorned grasshoppers as *Locustidae;* it is unfortunate, perhaps, that the two were not originally transposed, but it emphasises very well to a class of students what nomenclature means when one explains why Locusts are not in the family *Locustidae*, and in this way the transposition of names is useful. But we are now told, by another British Museum Catalogue, that what we knew as *Acridiidae* are *Locustidae*, that the old *Locustidae* are *Phasgonuridae*, and that the *Gryllidae* are *Achetidae*, in spite of the fact that the notable Orthopterists, Brunner, Saussure, and Bolivar, found no occasion to change the old names. Suppose these to be adopted; the student has some text-books with one set, some with another, and has to learn the relative uses of them before he can get to his real work. If any branch of the science benefited, it would matter less, but none does.

I write as a "practical entomologist" (to quote Mr. C. O. Waterhouse) who has to deal with injurious insects, who directs men studying the live insect in the field and insectary, and who teaches students; it is a constant burden finding out the equivalents in different countries of the important insects, it has to be taught to students if they are to use literature at all, and it adds a needless complexity to a subject already sufficiently complex. Furthermore, as our insects are revised by authors at home we have to substitute new names, and these have to be circulated to all our scattered staff so that confusion may be avoided.

In this matter, teachers and practical entomologists alone are concerned; to the systematic entomologist, the mazes of synonymy and priority are (apparently) the breath of life, and the pastime might be a quite harmless one; if one systematist wants to abuse another in

the pages of an entomological journal, no one minds; it even adds an element of farce to an otherwise too sober publication when one Hemipterist has remarks on another. But to practical men who wish to check the growing spread of insects from country to country, who wish to co-operate to deal with big problems, who see in agricultural education the chief solution of these big problems, the question is one of vital importance.

The remedy for this state of things seems to me to lie in the formation either of an association of economic and teaching entomologists, or in the joint action of the various Associations and Societies to form an international committee. Such a committee could direct affairs by correspondence, the different associations doing the work for their own countries; thus for the British Empire, the Association of Economic Biologists and the Entomological Society of London combined could (1) obtain from every economic entomologist a list of the insects he regarded as having a sufficient importance in literature to be "Standardised"; (such a list is in existence in India for practical work, and I presume most entomologists in the Colonies have such working lists). (2) Work these lists into one (where necessary such lists could be easily correlated if specimens were sent, an easy matter if the species is economic and therefore not rare) and prepare a single list giving (*a*) proposed designation; (*b*) designation in use in economic literature; (*c*) designations in use in standard catalogues which contain good descriptions. (3) This list is then sent to the International Committee, who, by taking the advice of known experts in different groups, prepare one list, which is published for comment. (4) The comments are then scrutinised, and where a clear majority of say two-thirds are in favour of a name, it is adopted and used by all who subscribe to the aims of the committee. A reference then to the "International Catalogue" would enable systematists and others to refer to economic literature, and the single reference to the "International Catalogue" would enable every entomologist to know what he was dealing with.

I give below instances of the method of dealing with individual cases; I would point out that a vast majority of the destructive insects are those first found and described; it is just with these that "priority" makes such changes, and the nomenclature of not more than one insect in a hundred of our present recorded species would be touched by the committee at all. The realisation of this will perhaps tend to make the proposal look less revolutionary to pure systematists. I would include in the Committee's scope, the question of family names; practical working entomologists would adopt, not a standard classification, but a standard designation for well-marked families; thus *Bruchidae* are being called

*Lariidae* and *Mylabridae*, solely on grounds of priority; the Committee would, in my opinion, adopt *Bruchidae*.

It is obvious that to regulate such a matter as this must depend upon the mutual agreement of economic entomologists, which will be obtained only by a reasonable policy of compromise. One cannot lay down hard and fast rules; if a rule were made, for instance, that a name in use for the last half century should stand, the literature of 1855-1860 would be sought for to see if or if not the species described came within that limit, and we should have shifted the trouble from the time of Linnaeus to the decade of half a century ago. Mutual agreement would be the backbone of the system, or the chaos of the future arbitrary change or retention of nomenclature would be equalled only by the present chaos, and would duplicate it. There is no alternative that one can see except an arbitrary use of names according to one's own judgment. We have in India a well known pest *Hieroglyphus furcifer*, Serv. Mr. Kirby now finds this to be *H. banian*, Fabr., and he revives this name. Why should we adopt it? All our literature is under *furcifer*, and by retaining that name, no confusion is caused; but, the name may be adopted in Ceylon, Burmah, and other places; readers of our publications will be careful to point out the mistake, and to anyone not up in the question, there will appear to be two species.

Another instance has quite recently occurred; a moth was reared from stored potatoes grown in India in a locality to which seed potatoes had been imported from Italy. The suspicion arose that this was the notorious "Potato Moth" (*Lita solanella*). Mr. Meyrick was good enough to identify it as *Phthorimaea operculella*. What connection is there between these two? If one looks up the *systematic* literature one finds they are the same; but what practical working entomologist can afford to do this in every case and for every species? It involves a great deal of time, a constant purchase of otherwise useless literature, and is a great tax, wholly unprofitable. If I arbitrarily use *Lita solanella*, because my assistants and students can then look it up in agricultural literature, and everyone else uses *Phthorimaea operculella*, how are economic entomologists to know that India is a distributing centre for this pest in seed potatoes, and how are they to take precautions? I think all economic entomologists will agree that we are immensely adding to the difficulties of our work, if it is to be anything more than parochial, either by modifying our nomenclature in accordance with the priority discoveries of systematists or by arbitrarily using the nomenclature we think most suitable. It is impossible for an isolated worker in a far country to do more than offer suggestions; I feel assured it will be for the permanent ultimate good

of our science if we can overcome this growing monster, and I think the Association of Economic Biologists might fitly take up the subject.

It is perhaps premature to suggest that this might usefully be the first problem for the "International Institute of Agriculture" at Rome, as far as it covers insects important to agriculture, since presumably the listing of the pests of all countries will be one of their aims; but, with the support of economic entomologists of all countries, it should not be difficult to fix on an uniform system of family nomenclature and, for each well-defined pest, a fixed specific and generic name.

## EXAMPLES.

(*a*) *Cimex* has been *Acanthia*; is now *Clinocoris* in America, *Klinophilos* in some literature. I would retain *Cimex*, these changes being purely due to priority. This is a splendid example: Bull. No. 47, cataloguing the Exhibit of United States Department of Entomology at Louisiana, dated 1904, gives "*Klinophilos lectularia*, Linn. (formerly *Acanthia* and *Cimex*)." Bulletin 53, dated a year later, listing the Exhibit at Portland, gives "*Clinocoris lectularia*, Linn. (formerly *Acanthia*, *Cimex*, and *Klinophilos*)." Here is a generic change in a popular exhibit and bulletin in one year.

(*b*) *Gelechia cerealella*, Ol., is now *Sitotroga;* this is due to revision of the unavoidably large genus *Gelechia*, and has the sanction of those who study *Microlepidoptera*, as being necessary. I would adopt the name as soon as the Association were satisfied that it was established in general use.

(*c*) *Pulex serraticeps*, Gerv., is now *Ctenocephalus canis*, Curt. If the genus *Pulex* must be split, owing to its including several genera, and if the name *Pulex* cannot be retained for all the "economic" ones (*i.e.*, species on which a literature exists), I would, after an interval, adopt the generic name; the specific change being simply a question of priority, would not be adopted.

(*d*) *Lecanium hemisphaericum* is now *Saissetia*, owing to division of the genus into several. In my opinion, the splitting of the genus is unnecessary, based on inadequate grounds, and I would vote for the retention of *Lecanium*; those to whom the sub-genera really conveyed anything useful could write *Lecanium* (*Saissetia*) *hemisphaericum*.

(*e*) Family Nomenclature.—A change in the designation of a family, on the grounds of a change in a generic name, should not be adopted; the actual names to be applied to Families to be settled and the equivalents listed; *e.g.*, the term *Trogositidae* should stand for the family containing the species known as *Trogosita mauretanica*, and any change would be rejected.

(*f*) *Leucania unipuncta*, Haw., designated, until recently, a pest practically world wide; Hampson, revising the genus, places it in *Cirphis;* the United States Department of Agriculture have adopted *Heliophila.* We have therefore the literature prior to 1900 say, under *Leucania*, the American literature now under *Heliophila*, and the literature of those who follow the British Museum Catalogue under *Cirphis*. This is to me a perfectly clear case where *Leucania* should have been retained for the part of the genus called *unipuncta*, regardless of priority, since it has been used for this important species for so long, and the economic literature under this designation vastly outweighs the importance of the systematic literature.

(*g*) *Psocus divinatorius*, Mull., was the original designation of the common household Psocid known the world over. The original genus was split, and the species passed as *Atropos divinatoria.* The American literature now designates it as *Troctes divinatoria.* In this case, I personally would vote for *Atropos.*

(*h*) *Protoparce convulvulli*, Linn., is the designation of the Eastern "Sweet Potato Hawk Moth," and is now regarded as the correct name for *P. singulata*, the Sweet Potato Hawk Moth of the Southern States and West Indies. Obviously both cannot stand; there is a literature under *cingulata;* there is none under *convulvuli*, and I would vote for the former. The genus has been revised by Hampson, who puts *convovuli* into *Herse*, by Rothschild and Jordan, who fix on "*Phlegethonthius.*" If this species is the most important economic species, I would have retained *Protoparce.* If it is not, I would not have retained *Protoparce* for that part of the genus (now split up) which contained the most important species, *if the Committee were convinced the genus must be split at all.*

(*i*) The termite of India is written of as *Termes taprobanes*, Wlk., whilst it is *T. obesus*, Ramb. This is a case of mistaken identification, and the nomenclature must, of course, be corrected, since the two species are quite distinct.

(*j*) *Sylepta multilinealis*, Guen., was the designation of the very abundant Cotton Leaf Roller of India, Burmah, Straits, Ceylon, and Africa. Sir George Hampson, delving in old books, finds it agrees with *derogata*, Fabr. In a case of this kind, since the reference to Fabricius as distinct from Guenee is absolutely no value to anyone, and since the various entomologists of the large area the pest covers all know it as "*multilinealis*," I would unhesitatingly reject *derogata* as useless and frivolous.

(*k*) *Pyrilla lycoides*, Wlk. An amusing interchange of compliments has recently taken place over a species known in India as the

"Cane fly." It was erroneously identified as *Dictyophara pallida*, Don., and this designation adopted in "Indian Museum Notes," in "Indian Insect Pests," and in the "More Important Injurious Insects of India" (Mem. Agri. Dept. India, I., No. 2), in which I tried to fix our nomenclature for the time. In all these there was a clear mistake in identification, and the name was incorrectly applied. Mr. Distant then refers to it as *Zamila aberrans*, and we have now a choice of *Zamila* and *Pyrilla* as generic, and of *aberrans* and *lycoides* as specific names, according as we follow Mr. Distant or Mr. Kirkaldy. To discover all this, we have to refer to three places, "the Fauna of India," the "Entomologist," the "Annals of the Belgian Entomological Society," and there is still a choice of name.

# SOME NEW AND UNDESCRIBED INSECT PESTS AFFECTING COCOA IN WEST AFRICA.

By

W. M. GRAHAM, M.B.,

*Director Medical Research Institute, Lagos, W. Africa.*

WITH PLATES VIII AND IX.

Family **Capsidae.**

Gen. ? nov. **longicornis,** n. sp.

Pl. VIII, figs. 1 and 2.

*Adult.*—Head buff, mottled with brown. Ocelli two on papilla between antennae. Antennae a reddish brown, the clubs being dark brown. 1st segment short and broad, 2nd segment long and club-shaped, 3rd segment short and club-shaped, 4th segment pear-shaped and short. Beak dark brown, becoming darker towards the apex, four jointed. Thorax, dorsum of pro- and mesothorax, and scutellum of a buff ground colour, covered with dark brown pits and elevations, giving them a rasp-like surface. Wings—elytron, clavus buff, with dark markings and covered with black hairs. Corium buff, covered with black hairs. Cuneus buff, somewhat paler. Cell of membrane and membrane, buff mottled with dark and lighter slate coloured spots. Hindwing hyaline, with clear yellow veins. Legs reddish-brown with darker brown bars. Tarsus two-jointed, distal joint pale. Abdomen broad and flat, light brown, smooth. Length, 11 millim.

*Hab.*—Brafu, Yedra, S. Ashanti.

The female is armed with a long, curved ovipositor, carried in a groove on the venter.

The nymph has a very similar colouration, but the dorsum of the abdomen is of a reddish ground colour, with dark brown rectangular spots raised above the surface.

Very large numbers of these insects were found on the diseased trees and not on the healthy ones. They appear to damage the trees by perforating the bark and so producing "gumming."

Large numbers of nymphs in all stages were found, but no larvae or eggs.

**Cryphalus horridus,** n. sp.

Pl. VIII, fig. 3.

Head a dirty yellow. Beak not apparent, short. Eyes dark purple. Antennae capitate and geniculate, dirty yellow. Elytra and

dorsum of thorax a dirty olive green, covered with transparent stubby bristles arranged in longitudinal lines. Ventral surface a dirty yellow. Legs a pale yellow colour. Third joint of tarsi not lobed, fourth joint visible. The body is cylindrical and thick set. Length, 1 to 1.25 millim.

These minute beetles burrow between the bark and wood of the branches and twigs of the cocoa trees. They must be looked for carefully beneath the bark, as they are not to be found on the external surface of the branch. They make long cylindrical galleries, or burrows, in the deeper part of the bark, and so arrest the flow of the sap. Deep scarring is produced, the leaves turn yellow and fall, and the branches break off very readily at the points of the deepest scarring.

These beetles have caused a great amount of injury to cocoa this year in many plantations in S. Ashanti.

Cocoa is not indigenous to Ashanti, where its cultivation has been recently introduced. Having found that a minute weevil beetle was the cause of the damage to the crop, it became very important to discover the indigenous plant from which the weevils had transferred themselves to the Cocoa. After considerable search, I found similar weevils breeding in the tough outer portion of the Papaw fruit.

It apparently follows from this observation:—

i. That the planting of Cocoa in close proximity to Papaw is undesirable.

ii. That when a Cocoa plantation is once infected with these weevils, Papaws planted among the Cocoa trees might act as a trap for the beetles. This, however, requires experimental proof. I should like also to draw attention to the superficial resemblance between the fruit of the Cocoa and the fruit of the Papaw. Both are very similar in shape and colouration, and both grow from the main stem of the plant.

It would thus seem probable that these beetles are guided, in their choice of a plant, by sight rather than by smell or taste, and this observation may possibly afford some indication of the direction in which, in future, similar search is likely to prove successful.

### **Ceratitis anonae**, n. sp.

Pl. IX, figs. 4-6.

The larvae are reared in the fruit of the Sour Sop (*Anona muricata*) and in that of the Guava (*Psidium cattleyanum*) in S. Ashanti.

*Female.*—Head, front broad, 1/3 width of head, lemon yellow with black orbital bristles. Cheeks fawn coloured. Eyes pale iridescent green, looking yellow, or brown, or blue, in parts, according to angle of

illumination. Ocelli on dark spot, with two ocellar bristles directed forward. Antennae yellow, a shade darker than the front. 1st segment short fringed with black hairs, 2nd segment short, studded with black hairs, 3rd segment three times length of 2nd segment. Arista pubescent, dark brown, long. Palps yellow, 2nd joint club-shaped and studded with black hairs. Proboscis a rusty-red, with fleshy labella bearing brown hairs. Thorax a greenish grey covered with pale yellow pubescence, with three dark brown longitudinal lines indistinct before, but broader and distinct behind the transverse suture, and ending slightly in front of scutellum in broad dark spots. Between these spots and scutellum is a narrow, shining glabrous band of cream or yellow. Pectus a dark brown. Pleurae lemon-yellow; rarely cream-coloured. Scutellum, the anterior third, is pale yellow or cream. The posterior two-thirds is shining black, divided into three parts by four golden narrow bands, which unite on the under side of the scutellum, four black scutellar bristles. Legs golden, middle tibiae with dark brown spurs. Abdomen broad, flat, of triangular shape, with well-marked flattened ovipositor. First segment pale buff or fawn, with a narrow dark brown basal band, covered with pale pubescence. Second segment with a dark brown apical band almost the entire width of the segment, covered with black pubescence. Third segment pale puff with pale pubescence. Fourth segment with a brown basal band. Ovipositor golden, first segment with brown apical band. Venter a pale brown. Wings broad and longer than body, transparent, with brown veins, and three transverse brown bands. A brown longitudinal between costa and third longitudinal vein, running from the anterior transverse vein to tip of wing. The middle transverse band has a golden spot, which lies in the first basal and in the discal cell. The longitudinal band has a golden central portion, and the brown edges are accentuated in four places as darker spots. There is in many specimens a faint, short brown band in the second posterior cell. In the basal part of wing, between the first and second transverse bands, there are eight brown dots, roughly arranged in two transverse lines. Halteres cream coloured, squama pale cream. Length, 6 millim.

*Male.*—Colouration similar to female. Front as broad as in the female. The antennae, thorax, pleurae, abdomen, and wings are very similar to those of the female. The legs differ: first pair, femora brown, tibia and tarsus golden; second pair, femora brown with long black hairs on under side, tibia brown with long black hairs on upper and lower edge, diminishing in length towards the tarsus, thus giving the appearance of a feather, tarsus golden; third pair, as in female. Length, 5.5 millim.

The fly is found walking lazily about on the leaves of various bushes, slightly vibrating its outstretched wings.

It is also found on palms where there are coccids.

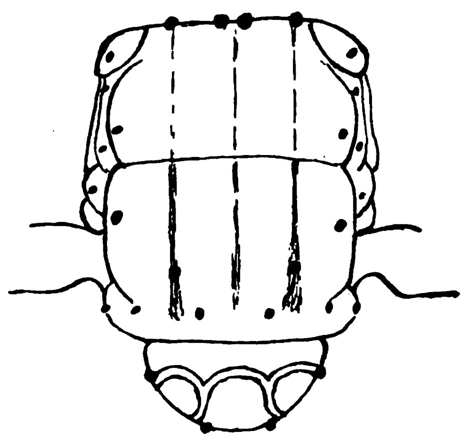

Fig. A.—Chaetotaxy of *Ceratitis anonae.*

Chaetotaxy.—This is, of course, *Trypetid* in character, but I may point out that this peculiar arrangement of the four bristles on the anterior edge of the mesothorax is very easily recognised by unskilled persons, is characteristic, and renders *Trypetidae* readilv distinguishable from flies with pictured wings, such as *Ortalidae* and *Sciomyzidae,* to which some of the *Trypetidae* bear a superficial resemblance.

I have added a drawing showing the chaetotaxy.

The *larva* is a white maggot with a black spot and two dark hooks at the head end. It is capable of leaping. When placed on earth the larvae bury themselves and become pupa in two days. The pupal stage lasts thirteen days.

The *pupa* is of a golden brown colour.

The types of male and female are in the British Museum (Natural History).

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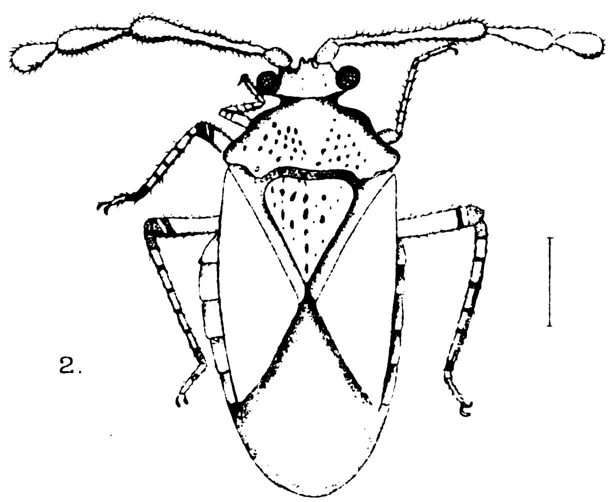

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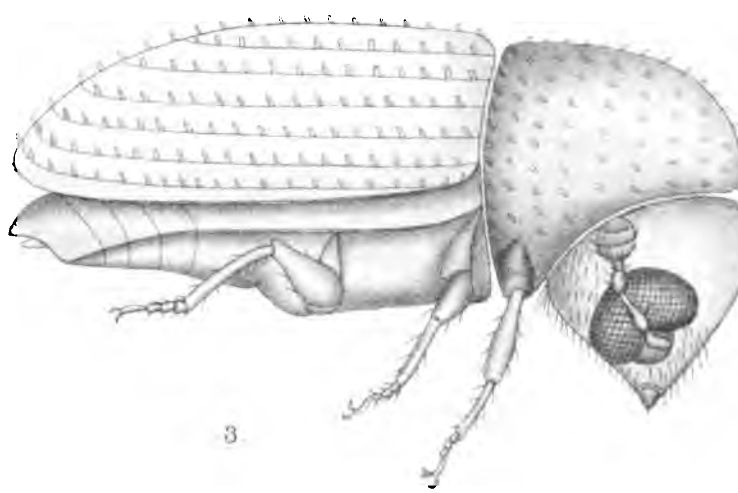

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NEW WEST AFRICAN INSECTS.

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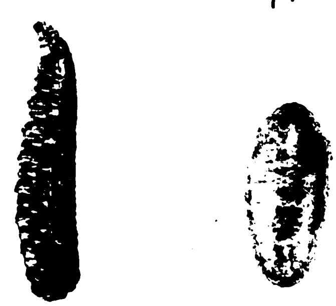

Bath, London.

CERATITIS ANONAE, *n. sp.*

## EXPLANATION OF PLATES VIII AND IX,

Illustrating Dr. W. M. Graham's paper on "Some New and Undescribed Insect Pests affecting Cocoa in West Africa."

### Plate VIII.

Fig. 1.—Nymph of ? *longicornis*, n. sp., found on diseased Cocoa plant at Brafu, Yedra, S. Ashanti.

Fig. 2.—Adult female.

Fig. 3.—*Cryphalus horridus*, n. sp. Adult female. × 97.

### Plate IX.

Fig. 4.—*Ceratitis anonae*, n.sp. Male.

" 5.— " " " Female.

" 6.— " " "

*a.*—Larva.

*b.*—Pupa.

The small divisions of Scale represent millimetres.

# THE FUTURE DEVELOPMENT OF TECHNICAL MYCOLOGY.[1]

BY

EMIL WESTERGAARD, Ph.D.

ONE of the most striking examples of the recent rapid progress of pure and applied science is, without doubt, to be found in the rise of Technical Mycology. From being, for obvious reasons, non-existing prior to Pasteur, this branch of applied science, or rather the numerous branches which we now gather together under that common name, has since then developed into a position of one of the most fruitful and practically important subjects of the present time. The progress has indeed been so rapid, the amount of experimental work and the mass of literature so great, that it would seem not unprofitable to devote a few minutes to a consideration of the present position, and to try, if possible, to form an idea of the probable lines of further development in the immediate future. This would seem to be so much more useful as, owing to the reasons already mentioned, and also, and perhaps to an even larger extent, to the newness of the subject, the term "Technical Mycology" conveys, I am afraid, but a very vague meaning to most people who are not actually engaged in its pursuit.

Whilst the foundation-stone of this new science was laid by Pasteur through his demonstration of the importance of the presence and activity of distinct species and varieties of micro-organisms, it was reserved for Emil Chr. Hansen to show how our knowledge of microscopic plant life could be turned to practical use, and thereby to initiate the science of Technical Mycology as such. His idea, the systematic selection in each individual case of the most suitable type and the exclusion of all others, has, as you are undoubtedly aware, been adopted by the brewing industry throughout the world with the most conspicuous success. The same principle has since been applied to the distillery and yeast-making industry, chiefly by the Berlin school, and to wine-making by Muller-Thurgan and Wortmann, while in dairying the works of Duclaux and v. Freudenreich need only to be mentioned. While the importance of micro-organisms in the ripening of cheese is still a disputed question, their influence can scarcely be disregarded.

[1] Read before the Association of Economic Biologists, Edinburgh Meeting, July 29th, 1908.

[JOURN. ECON. BIOL., 1908, vol. iii, No. 4.]

Even if it be admitted that the characteristic ripening of certain, or perhaps all kinds of cheese, is largely due to the activity of the natural enzymes of the milk, it is hardly possible not to ascribe to the bacteria at least some substantial part in the results. Even if bacterial influence should be shown to be of a negative nature only, we have still to reckon with the fact that the presence of lactic acid bacteria acts as a preventive against the development of the members of the putrefactive groups. The use of pure cultures in butter-making and recently in the manufacture of margarine, has given the most excellent practical results, of which the high reputation enjoyed by Danish butter affords a good example. This reputation very largely rests upon the uniformity of the quality, the natural result of the pure culture system.

Turning next to the greatest of all human industries—agriculture—we find that the questions which have so far chiefly engaged the attention of the technical mycologist are those connected with the bacteriology of the soil, and more especially the assimilation of free nitrogen, the nitrification and the denitrification. The first mentioned of these three questions is as yet very much in an experimental state, at least as far as practical results are concerned. The fixation of free nitrogen is of the highest importance in nature's economy, and the questions connected therewith are of such vital interest to the human race, that the discovery of the nodule bacteria of the *Leguminosae*, of the *Chlostridium pasteurianum* and the Azotobacter species, ranks among the most important scientific achievements of modern times. The apparent contradiction in the results of the practical experiments with pure cultures of nitrogen-fixing bacteria, finds its natural explanation in the pre-existence in the experimental fields of either sufficient nitrogenous food material for the plants or of an abundance of the necessary bacteria, or both. However, the question is only in its infancy, and presents a very promising field for further research, in the course of which it may possibly be found that the faculty of fixing free nitrogen is shared by numerous other organisms.

These few instances may suffice as examples of the direct utilisation of micro-organisms, or as it might be called the positive application of Technical Mycology. This science has, however, another side which may be called the negative one, consisting in the guarding against the inroads of micro-organisms which, by their development and activity, might exercise a more or less harmful influence upon the process of manufacture and the results of the industry. As examples may be mentioned sugar, starch, gelatine, and preserve works. Hereunder come the various processes of complete or partial sterilisation by heat, filtration, or chemical antiseptics, and, in a wider applica-

tion of the term, all the precautions against the spreading of infectious diseases of animals and plants. Pathological Mycology is, however, usually regarded as being outside the sphere of the Technical Mycologist, to which it can only be said to belong if fungi and bacteria are utilised directly to combat the disease-bringing organisms.

Of this we have a beautiful illustration in Metschnikoff's regulation of the bacterial flora of the alimentary canal by means of a systematic introduction of pure cultures of lactic acid bacteria.

This brings us on to the point on which I desire to say a few words, namely, the importance of the influence which micro-organisms exercise upon each other's development. The line which Technical Mycology has followed hitherto, and naturally must follow, has been the isolation of the most suitable species, variety, or type, for the particular industry in question, and an attempt to prevent complications by a rigorous exclusion of all others. The excellent results obtained in this manner have already been briefly alluded to and require no further comment, they speak for themselves. But it is nevertheless quite clear that if further substantial progress is to be made, not only in connection with the industries already within the domain of Technical Mycology, but if that science is to be extended to embrace other industries, the field of operations will require to be considerably widened. Just as we in the Algebra commence by considering the equations of the first degree, and gradually go on to the discussion of those of the second, third, and higher degrees, so we have in Technical Mycology commenced by mastering the problems of the first degree, those involving one soecies or variety of organism only, and are now face to face with the problems of the second and higher degrees, involving the simultaneous development of one or more either closely allied varieties or widely different species. These problems naturally fall into two classes. On the one hand we have such cases where any one species or variety does not carry out the entire amount of work required, and on the other hand we have such cases where the difficulties in sterilisation for one reason or another render the working of a pure culture, with the exclusion of admixtures, an impossibility. In addition may be mentioned those cases where the activity of micro-organisms is not in itself desired, but, as it cannot be avoided, an attempt is made to regulate it. As an example of the first class I should mention the brewing of British beers. Numerous, unfortunately unsuccessful, attempts have been made to carry through the fermentations of these by means of a single pure culture on the lines which have been such a great success in every other class of brewing. In a paper read before the Institute of Brewing, and afterwards in the Keith Lectures to the Royal Scottish Society of

Arts, I have expressed my views as to the lines on which this highly important and interesting question may be solved. These views are based upon numerous observations in practice as well as in the laboratory, indicating that when a mixture of micro-organisms is continually cultivated under the same set of conditions—food, temperature, time, etc., an equilibrium is soon established, after which the proportions in which the individual members are represented in the mixture are not changed to any appreciable extent. (It goes, of course, without saying, that this proportion may be, and in the majority of cases is, = 0; this is, the variety in question is eliminated). The exact scientific proof of the correctness of this statement is, unfortunately, still wanting, owing to the almost prohibitive difficulties in identifying such large numbers of cultures, so closely resembling each other, as would be necessary in this case. However, I have the best hope that I shall, before long, be able to complete this part of the work. As examples of the second class, we have distilling and yeast making and cheese making. It is well enough known how the temperature, and, in the case of distilling and yeast making, the reaction of the wash is regulated in order to control the development of micro-organisms. In this last-mentioned case we have in addition an example of the utilisation of bacteria, which are not in themselves desired, but are harmless, for the purpose of preventing the development of others. I allude to the addition of lactic acid bacteria to prevent Butyric fermentation. Of further examples of this class we have Metschnikoff's use of lactic acid bacteria, to which I have already referred. The question I propose to treat separately, and I shall, therefore, just now proceed to state the conclusions to which I have come.

"As it is only in exceptional cases that it is possible to work in practice with pure cultures absolutely free from the admixture of other organisms, and as it is necessary for the successful carrying on of several industries that more than one species or variety be employed, it is essential that the conditions affecting the relative development in mixtures of micro-organisms receive the most close attention of the Technical Mycologists."

This necessity opens up an almost unlimited field closely connected with biochemistry. The problems would seem to resolve themselves largely into a study of the enzymes and anti-enzymes, and the toxins and anti-toxins, the conditions regulating the production and activity of these, and the manner in which the development of the individual members present in mixtures are thereby affected.

In many cases the problem is probably simple enough, as for instance the suppression of *Saccharomyces apiculatus* in the wine

fermentation apparently by the large amount of alcohol produced by the wine yeast, or the prevention of putrefaction by the acid-forming species. But in numerous other cases the influences are undoubtedly of a far more subtle nature as, for instance, in the development of a British brewing yeast, or in the development of various bacteria in milk. It is true that if in this latter case the development of the lactic acid species is allowed to proceed sufficiently far to form an appreciable quantity of free acid, the retarding effect of this upon the development of a great many other organisms will be so strong that it will overshadow most other factors. I am, however, convinced from what I have seen during my work with bacteria in milk that there are other factors at work, and I propose to lay before you the results of my experiments so far as they go and incomplete as they are.

It is now a couple of years since Dr. A. P. Laurie called my attention to Metschnikoff's ideas, and suggested that I might be able to do something to have these introduced into this country. After having made myself acquainted with the literature on the subject, I proceeded to isolate a number of lactic acid bacteria from various sources. In estimating the relative value of these I used their power of retarding the development of a culture of *Bacillus coli communis*. I chose this method partly because it appeared to me that members of this group were the principal mischief makers in the alimentary canal, partly because it seemed evident that the suppression of members of the putrefaction groups would present no difficulties, and partly because the *Bacillus coli* varieties being themselves lactic ferments, would probably be in a position to offer more resistance towards the lactic acid bacteria than most others, so that a type of the latter which was able to combat successfully *Bacillus coli* might be confidently expected to come out victorious from the competition with most other species.

The culture which I finally adopted was a *Streptococcus* form obtained from a sample of butter from Normandy, and of this I supplied during nearly a year a large number of samples daily to several of my friends in the medical world. I do not propose to say anything about the medical aspect of the question, on which I am, of course, totally incompetent to speak, but I shall only refer to a publication by Dr. A. Veitch in the "British Medical Journal" (10th August, 1907), and I hope that others will soon be in a position to publish their results, which, I understand, are in many cases of a highly satisfactory nature.

In the following experiments the culture of *Streptococcus acidi lactici* already referred to was used. The culture of *Bacillus coli communis* was obtained by isolation from human faeces and developed in Glucose-Peptone Solution ($\frac{1}{2}$% Peptom Witte and 2% Glucose).

## EXPERIMENT (A).

Both cultures were developed for 24 hours at $37\frac{1}{2}^{\circ}$ C. in Glucose-Peptone. One drop of each of these cultures was added to a Freudenreich flask containing about 7 cc. Glucose-Peptone Solution, which was then placed in the incubator at $37\frac{1}{2}^{\circ}$ C. From this neutral Glucose-Peptone-Gelatine, plates were made after 24 hours and 48 hours incubation. One drop of the culture was diluted with 10 cc. sterile water. Of this dilution one drop was again transferred to 10 cc. sterile water, and from this one drop transferred to the Gelatine. After development the number of colonies of each type was counted, the difference in their appearance being of course sufficiently great to make this a comparatively easy, although rather tedious, piece of work. For further confirmation twelve colonies of each description were taken out of each plate in this and also in the following experiments, developed in Glucose-Peptone Solution and examined under the microscope.

### RESULTS OF COUNTING.

Plate made after 24 hours. Total number of colonies = 75.

| | |
|---|---|
| B.C.C. ... ... ... ... ... ... | 6.6% |
| S.A.L. ... ... ... ... ... ... | 93.4% |

Plate made after 48 hours. Total number of colonies = 631.

| | |
|---|---|
| B.C.C. ... ... ... ... ... ... | 12.8% |
| S.A.L. ... ... ... ... ... ... | 87.2% |

## EXPERIMENT (B).

Same as (A) with the exception that a large excess of calcium carbonate powder was here added to the Glucose-Peptone Solutions.

### RESULTS OF COUNTING.

Plate made after 24 hours. Total number of colonies = 2,800. (Only one-fourth of the plate counted).

| | |
|---|---|
| B.C.C. ... ... ... ... ... ... | 8.8% |
| S.A.L. ... ... ... ... ... ... | 91.2% |

Plate made after 48 hours. Total number of colonies = 317.

| | |
|---|---|
| B.C.C. ... ... ... ... ... ... | 11.3% |
| S.A.L. ... ... ... ... ... ... | 88.7% |

These results would seem to show :—

(1). That the S.A.L. possesses in a very high degree the power of checking the development of B.C.C.

(2). That during the initial, and probably decisive, stages in the competition, this power does not depend upon the formation of lactic acid, as in both experiments a slight increase in the percentage of B.C.C. colonies is observed in the 48 hours plates as compared with those made after 24 hours, and, further, the results are practically identical in both experiments, the presence of calcium carbonate having apparently no effect.

## EXPERIMENT (C).

The object of this experiment was to show to what extent the presence of B.C.C. in overwhelming numbers from the beginning of the experiment would affect the results. The Glucose-Peptone Solution was therefore infected with a drop of the B.C.C. culture alone, incubated for 24 hours at $37\frac{1}{2}^\circ$ C., and then a drop of the S.A.L. added. The culture was then again placed at $37\frac{1}{2}^\circ$ C., and plates made after 24 and 48 hours as before.

### Results of Counting.

Plate made after 24 hours. Total number of colonies = 473.

| | |
|---|---|
| B.C.C. ... ... ... ... ... .... | 11.8% |
| S.A.L. ... ... ... ... ... ... | 88.2% |

Plate made after 48 hours. Total number of colonies = 1,374.

| | |
|---|---|
| B.C.C. ... ... ... ... ... ... | 8.1% |
| S.A.L. ... ... ... ... ... ... | 91.9% |

From these results it will be seen that the large number of B.C.C. has not seriously affected the development of S.A.L., and it would seem justified to expect that if the conditions were reversed, if the B.C.C. had to compete against a very large majority of S.A.L., it would scarcely develop at all.

The results of experiments (A) and (B), however, seemed to indicate that the position might possibly be a more complicated one, and in order to try this the following experiment was carried out, in which the only difference from (C) was that in this case S.A.L. had the 24 start.

### Results of Counting.

Plate made after 24 hours. Total number of colonies = 90.

| | |
|---|---|
| B.C.C. ... ... ... ... ... ... | 5.5% |
| S.A.L. ... ... ... ... ... ... | 94.5% |

Plate made after 48 hours was lost by accident.

Taking the results of all four experiments together, the evidence seems to be in favour of the opinion that the retarding effect upon the

development of B.C.C. exercised by S.A.L. is not merely due to the formation of lactic acid, and would further seem to indicate that if mixtures of the two bacteria here mentioned are cultivated under conditions which preclude the formation of large quantities of free lactic acid, an equilibrium between the two species, approximately in the proportion of 1 to 9, would be established.

It seems quite possible that the power possessed by the lactic acid bacteria of retarding the development of other bacteria, or at least most of the bacteria in milk, could be utilised for the purpose of increasing the purity of our milk supply. The bacterial contents of milk, as it is now retailed, more especially in large cities, are such that improvements are very urgently needed, as is amply proved by practically every report from Medical Officers of Health. Excellent information on this subject is also contained in the report just issued by the Committee appointed by the East and West Ridings of Yorkshire and adjoining counties, in which it is clearly shown how much can be done by observing the most scrupulous cleanliness in the dairy farms as well as in the retailers' and consumers' places; but the question still remains whether a milk supply obtained under the most ideal conditions that would be practicable, could be safely regarded to be without risk of causing or spreading disease. The remedy which has so often been advocated and tried—but so far with very little success—is that of sterilising, or partly sterilising the milk. The great objection to this process is that milk so treated will still contain a fairly large number, especially of spore-forming bacteria, which, when the milk is kept, will develop side by side with those bacteria which reach the milk after the sterilisation process. As the lactic acid bacteria have all been killed, such milk will not become sour and thereby indicate that it has been kept too long, in fact a sample of so-called sterilised milk may perfectly well be swarming with bacteria without exhibiting any sign of their presence, at least not to the eye of the ordinary consumer, who has been accustomed to look upon any sample of milk that is not sour as being good. What calamities can be, and undoubtedly are being caused by the use of such milk which is actually in a state of decomposition, can better be imagined than described. If the milk, however, had received immediately after the sterilisation process just a trace of a pure culture of lactic acid bacteria specially selected for the purpose, this great objection and danger would have been entirely done away with. The presence of these bacteria would not only retard the development of others, but would ultimately, by their own development, indicate when the milk had been kept too long; and quite apart from the question of sterilising the milk, it would seem quite possible to

improve the purity of the natural milk by the addition of such cultures immediately after the milking process. The cost of this, if it were carried out regularly, would be quite insignificant, and the presence of the lactic acid bacteria in the milk from the very outset would probably afford the best safeguard against the development of the various more or less undesirable species.

Before concluding, I think I should mention that the experiments which I have described were not carried out with a view to publication, at least not in their present form, but when I was requested a few weeks ago to make some remarks at this meeting, it occurred to me that the results, and the ideas which they seem to suggest, might be of interest to some of those present.

## NOTES.

### Preliminary Note on the Action of Yohimbine on the Generative System.

BY

**W. CRAMER, Ph.D., D.Sc., and F. H. A. MARSHALL, M.A., D.Sc.**

*(From the Physiology Department, University of Edinburgh.)*

Seeing that the drug Yohimbine is commonly stated by veterinarians to act as an aphrodisiac, and that it has been claimed by some to be capable of inducing a condition of "heat" in animals and to be an effective remedy for certain kinds of sterility, it seemed desirable to undertake a systematic investigation upon the precise nature of the action of this drug on the female generative organs. We first administered it to two small anoestrous bitches, the date of the preceding "heat" period having been noted for one of them, but not for the other. Each animal received about .005 grams of Yohimbine twice daily, for nearly a fortnight, the drug being administered in the form of tablets, which were eaten. A marked congestion of the vulva resulted, especially in the case of the dog whose previous "heat" period had been noted to occur a few weeks previously.

After ceasing to administer the drug the effects passed off, and the vulva once more became pale. This result agrees with that obtained by Daels ("Surgery, Gynaecology and Obstetrics," February, 1908).

We then proceeded to investigate the effects of Yohimbine on the generative organs of rabbits. These animals received twice daily doses of .005 grams by the mouth in the form of tablets. The external generative organs became very deeply congested after a few days. Moreover, it was found on killing the rabbits that the uterus and entire generative tract were also congested, sections showing that the vessels were much engorged with blood. It also appeared that the uterine mucosa had undergone growth in consequence of the treatment, but whether these changes are to be regarded as truly prooestrous must still remain an open question. The ovaries were much overgrown by luteal tissue, and degenerate follicles, which are generally so common in rabbits' ovaries, were relatively scarce. It seems extremely probable, therefore, that Yohimbine, by preserving a constant and rich supply of blood, and consequently of nutriment, to the ovaries, may arrest the normal process of follicular degeneration, and so be the means of bringing a larger number of follicles to maturity than would otherwise be the case, thereby tending to increase the fertility. There was no evidence, however, that Yohimbine by itself is capable of

inducing ovulation in the rabbit, this animal differing from most in its failure to ovulate, except as a result of a nervous reflex set up by sexual intercourse.

Lastly, evidence was adduced that Yohimbine may promote mammary development and the secretion of milk, since in five rabbits to which the drug was administered milk was found in considerable abundance in the glandular tissue, in spite of the fact that the animals had not recently been suckling; while in another virgin rabbit there was distinct evidence that Yohimbine had promoted a hypertrophy of mammary tissue to an extent at least as great as that observed by Miss Lane-Claypon and Starling after the injection of foetal extract. It will, however, be necessary to confirm this observation before we can speak more definitely in regard to the action of Yohimbine on the mammary glands.

## A Note on Abortion as a Result of a Diet rich in Carbohydrates.

BY

**W. CRAMER, Ph.D., D.Sc., and F. H. A. MARSHALL, M.A., D.Sc.**

*(From the Physiology Department, University of Edinburgh.)*

In a recent paper (Proc. Roy. Soc., B. 1908), Lochhead and Cramer showed that in the pregnant rabbit there is a distinct relation between the amount of glycogen in the placenta and the growth of the foetus. A diminution in the glycogen of the placenta, whether occurring spontaneously or produced experimentally, was accompanied by a diminution in the weight of the foetus. The amount of glycogen present at any one day of pregnancy was found to be remarkably constant, and could not be increased by feeding the pregnant animals on a diet rich in carbohydrates (carrots). It was noted, however, that out of six pregnant animals which were kept on such a diet, three aborted.

In the present investigation the effect of such a diet was tested again on twelve female rabbits, which were kept intermittently with the same buck. Six of them were then fed on cabbage and carrots, while six others were fed on cabbage and oats, the latter serving as controls. Of the six control animals all had normally developed young ones. Of the six rabbits fed on carrots, three aborted at different stages of pregnancy.

This result agrees with the experience of many stock owners, that cows fed on molasses prove to be uncertain breeders (See Wallace: "Farm Live Stock," 1907), and that Lincoln sheep fed solely on turnips are especially liable to abortion (Heape, Journ. Roy. Agricultural Soc., 1899), but the last-mentioned fact has been ascribed by Heape to the fouling of the roots by mud and excrement, a condition of things which results from overcrowding.

## REVIEWS.

**Bailey, L. H.**—The Horticulturists Rule Book. Pp. ix + 312. Toronto: The Macmillan Company of Canada, Ltd., 1908.

This is a special edition of Professor Bailey's well-known handbook printed for the Government of British Columbia, for distribution amongst members of the Farmers' Institute.

It is cram full of valuable and useful information bearing upon insecticides, injurious insects, plant diseases, injuries from mice, rabbits, birds, etc., weeds and moss, seed-tables, planting-tables, and information upon the methods of keeping and storing fruits and vegetables, in addition to a large series of tables, elements, symbols, analyses, etc., etc.

We commend this handy reference book to all horticulturists and gardeners.

W. E. C.

**Henslow, G.**—The Heredity of Acquired Characters in Plants. Pp. xii + 107. London: John Murray, 1908. Price 6s. net.

The Rev. George Henslow, in this volume, maintains the thesis that evolution in plants depends on the inheritance of characters which have their origin in direct adaptation of the organisms to new environments; adaptations which become fixed or hereditary if the plants live long enough, generation after generation, in their new surroundings. Opposed to this is the view that variations are congenital, appearing in the seedlings, the unfit being eliminated, whilst the fittest survive, a view in harmony with Weismann's theory of the germ plasm.

Numerous examples in support of the author's view are marshalled from such groups of plants as the xerophytes (drought-loving plants), climbers, aquatics, etc. It is argued that in the xerophytes the succulent habit is a direct adaptive response on the part of the plant to the new environment, and that through successive generations this succulency becomes hereditary. In this, as in his earlier book, "The Origin of Plant Structures by Self-Adaptation to the Environment," the author appears to consider one factor to the exclusion of others. The environment cannot alone be the direct cause of the succulent habit, because examination of various plants, growing under the same conditions, shows that whilst some plants are succulent, others have underground bulbs and rhizomes, hairy leaves, a spinous habit, an extraordinary development of the root system, and so on. In other words, the same environment produces very dissimilar results, according to the personal equation of the plant and its response to tendencies already hereditary and not directly induced *de novo* by the action of the environment alone.

It is impossible, in a brief notice such as this, to do full justice to a book which, with the author's previous works, will be appreciated by botanists for the wealth of interesting examples cited, even although in all cases we find ourselves scarcely able to accept fully his conclusions.

The book is well produced and illustrated.

W. F. G.

**Hunting, William.**—Glanders, A Clinical Treatise. Pp. 105, with 17 plts. London: H. and W. Brown, 1908. Price 10s. 6d. net.

Veterinary science, and pathologists in particular, are much indebted to the author for this beautifully illustrated treatise. No one in this country is more capable or better qualified than Mr. Hunting to write on the subject of glanders, for he has taken a keen interest in, and has been practically associated with, the disease for now nearly a quarter of a century.

Modestly, but with a dogged pertinacity, he has spared no effort to keep the importance of the subject before succeeding Governments, and to impress upon them the seriousness of the disease to the health and wealth of the nation.

The disease is lucidly described, its history, etiology, symptoms, post-mortem appearances, diagnosis, the mallein test, cure and recovery, prevention and legislation, with an important appendix on glanders in man.

The work cannot fail to help those whose experience is small, in providing them with the fullest information, and will assist them to detect and suppress the disease should they meet with it.

There is little doubt but that so valuable a contribution to the literature of veterinary pathology will find a place in the library of everyone who has to deal with diseases of the horse. It is ably written, and leaves nothing to be desired in the manner in which it has been presented to the public.

W. E. C.

**Neumann, L. G.**—Parasites et Maladies Parasitaires des Oiseaux Domestiques. Pp. viii + 230, 89 text figs. Paris: Asselin et Houzeau, 1909.

In a remarkably small compass Professor Neumann has given an admirable description of the parasitic diseases of fowls and other domestic birds.

The descriptions of the various parasites are concise, lucid and well-illustrated throughout, whilst the inclusion of the common and scientific names and authorities make this a most useful handbook.

No pains seem to have been spared to make it as thorough and complete as possible.

W. E. C.

**Pickering, S. U., and Theobald, F. V.**—Fruit Trees and their Enemies, with a Spraying Calendar. Pp. i + 113. London: Simpkin, Marshall, Kent and Co., Ltd., 1908. Price 1s. 6d. net.

It is difficult to imagine what induced the authors to compile the little work before us. All that it contains has been said before and said much better, whilst its brevity, in many cases, detracts from its value.

The much debated "Woburn Washes" are strongly recommended, but up-to-date fruit growers will, we feel sure, hesitate before they treat their trees with caustic soda emulsions and paraffin mixtures. As is now well-known both caustic soda and paraffin do considerable harm to plant life, and are only partially successful in the destruction of insect pests; apart from this fact, their price is beyond the reach of the man who grows for profit.

The injunction to collect and burn all fallen leaves, as they may be infested with eggs, etc., of injurious insects, fungus spores, etc., if carried out, would mean two to three months' hard work for a small army of men, which practical fruit-growers will smile at. Such an injunction as this is most unfortunate, coming as it does from the advisers of the Duke of Bedford's Experimental Fruit Farm and the Wye Agricultural College.

W. E. C.

**Fuhrmann, O.**—Die Cestoden der Vögel. Zool. Jahrb. Suppl. 10, plt. i. Pp. 232. Jena: Gustav Fischer, 1908.

Dr. Fuhrmann has written a most interesting work, both from the standpoint of the parasitologist as well as ornithologist. The fact that the different parasites bear a distinct relationship to the different groups of birds is one worthy of further study.

It is, however, as a treatise on parasitology that it commends itself to our notice. As is fairly well-known the Cestodes are especially numerous amongst birds, and present many widely differing types. No less than sixty-four generic types are here treated of, together with the particular group of birds in which they are found. In many cases these generic types include a large number of species, all of which are set forth with full details.

The work is of considerable value to the parasitologist, and cannot fail to interest economic biologists generally.

W. E. C.

## CURRENT LITERATURE.

### I.—General Subject.

### II.—Anatomy, Physiology, and Development.

**Bordas, L.**—Recherches sur les glandes défensive ou glandes odorantes des Blattes. Ann. d. Sci. Nat. (Zool.), 1908, pp. 1-25, pl. i.

**Bruntz, L.**—Les reins labiaux et les glandes cephaliques des Thysanoures. Arch. Zool. exp. et gen., 1908, pp. 195-238, pls. ii, iii.

**Carter, R. M.**—A Preliminary Note on Spirochaetosis in Southern Arabia and the Morphology of the Parasite. Indian Med. Gaz., 1908, pp. 370-374, plts. i-v.

**Felt, E. P.**—Circumfili of the *Cecidomyiidae*. New York State Mus., Bull. 124, 1908, pp. 305-307.

The peculiar antennal structures first discovered by Targioni-Tozetti in 1888, are most highly developed in the male Diplosids, where they consist of nearly homogenous whorls of long, looped filaments extending around the enlargements of the segments. These structures occur practically in all the *Cecidomyiinae*, but are not present in the *Lestreminae*. In the genus *Lasioptera* they are extremely simple in form, and in *Cincticornia* they present somewhat remarkable modifications, whilst the most unique type is found in the genus *Winnertzia*.

The author puts forward the view " that these organs may be hypodermal structures, which, through a process of development, have migrated from the interior of the antennal segment, becoming external, and thus greatly increased their value as auditory organs." An alternative explanation is that they are simply specially modified setae, and this is the view we prefer to take until further evidence is forthcoming.

**Hewitt, C. Gordon.**—The Structure, Development and Bionomics of the House-fly, *Musca domestica*, Linn. Pt. II. The Breeding Habits, Development and Anatomy of the Larva. Quart. Journn. Micro. Sci., 1908, pp. 495-545, plts. 30-33.

**Minchin, E. A.**—Investigations on the Development of Trypanosomes in Tsetse-Flies and other Diptera. Quart. Journ. Micro. Sci., 1908, pp. 159-260, plts. 8-13, and 2 text figs.

**Nuttall, G. H. F., Cooper, W. F., and Robinson, L. E.**—On the Structure of "Haller's Organ" in the *Ixodoidea.* Parasitology, 1908, vol. i, pp. 238-242, plt. xviiii, 1 text fig.

From an examination of the structure of this organ, which is borne on the dorsal surface of the tarsus of the first pair of legs, the authors come to the conclusion that it is not auditory in function, but, as advanced by Lahille in 1905 from experiments, olfactory.

The minute structure is now described for the first time, and this and Lahille's experiments are all strongly in favour of the assumption that the organ is olfactory in function.

**Patton, W. S.**—Preliminary Report on the Development of the Leishman-Donovan Body in the Bed Bug. Sci. Mem. Off. Med. San. Dept. Govern. India, 1907 (n.s.), No. 27, pp. 1-19, 1 plt.

**Thompson, O. S.**—Appendages of the Second Abdominal Segment of Male Dragon Flies (Order Odonata). New York State Mus., Bull. 124, 1908, pp. 249-263, figs. 17-28.

## III.—General and Systematic Biology, and Geographical Distribution.

**Chadwick, G. H.**—A Catalogue of the "Phytoptid" Galls of North America. New York State Mus., Bull. 124, 1908, pp. 118-155, plt. 3.

The author gives a list of host plants on which leaf-galls occur. We fail to see the value of such. A list of the *Eriophyidae* of North America would have been extremely useful.

**Cockerell, T. D. A.**—A Remarkable Cecidomyiid Fly. Canad. Entom., 1908, pp. 421, 422.

Under the name of *Hormomyia coloradensis*, n.sp., the author describes a somewhat peculiar Cecidomyiid, in which the third vein of the wing is continued straight to the base of the fifth, and a little cross-vein to the first, which is supposed to be the real beginning of the third, is totally absent.

**Felt, E. P.**—New Species of *Cecidomyiidae. II.* New York State Mus., Bull. 124, 1908, pp. 286-304.

Fifty-one new species are described.

**Felt, E. P.**—Studies in Cecidomyiidae. II. New York State Mus., Bull. 124, 1908, pp. 307-422, plts. 33-44, figs. 29-49.

A valuable paper containing much new information respecting the American *Cecidomyiidae* and the Family as a whole.

The following genera are described as new:—*Microcerata, Neolasioptera, Camptoneuromyia, Diarthronomyia, Walshomyia, Sackenomyia, Cincticornia, Dentifibula, Lobodiplosis, Karshomyia, Youngomyia, Pro-*

*diplosis, Odontodiplosis, Adiplosis, Hyperdiplosis, Giardomyia, Metadiplosis, Epidiplosis, Paradiplosis, Obolodiplosis,* and *Johnsonomyia.* Many of these are founded upon little more than specific characters, and we regret that the author has not, at all events for the present, included them in existing genera.

**Girault, A. A.**—The Oviposition of *Chilocorus bivulnerus,* Mulsant. Journ. Econ. Entom., 1908, vol. i, pp. 300-302.

**Houghton, C. O.**—Notes on the Lesser Clover-leaf beetle (*Phytonomous nigrirostris,* Fab.). Journ. Econ. Entom., 1908, vol. i, pp. 297-300.

**Howard, C. W.**—A List of the Ticks of South Africa, with Descriptions and Keys to all the forms known. Ann. Transv. Mus., 1908, vol. i, pp. 73-169, plts. i-xvi.

Although describing no new species, this is a most useful and valuable paper. In addition to giving full diagnostic characters, and numerous figures, the author includes a bibliography of South African ticks and a list of the animals which act as hosts for the same.

**Johannsen, O. A.**—New North American *Chironomidae.* New York State Mus., Bull. 124, 1908, pp. 264-285.

**Kirby, W. F.**—A Gall-producing Dragon-Fly. Nature, 1908, p. 68.

**Mercier, L.**—Recherches sur les bactéroides des Blattides. Arch. Protistenkunde, 1907, Bd. ix, pp. 346-358, 2 Tafn.

**Meunier, F.**—Monographie des *Empidae* de l'ambre de la Baltique. Ann. d. Sci. Nat. (Zool.), pp. 81-135, plts. iii-xii.

**Needham, J. G.**—New Data concerning May Flies and Dragon Flies of New York. New York State Mus., Bull. 124, 1908, pp. 188-248, plts. 10-32, and figs. 5-16.

**Neumann, L. G.**—A new species of Tick from the Transvaal. Ann. Transv. Mus., 1908, vol. i, pp. 170-172.

The new species is named *Rhipicentor vicinus.*

**Pease, S. A.**—Parasites and the State Insectary. Rpt. 34th Fruit Growers' Convention Calif., 1908, pp. 39-49.

**Pierce, W. D.**—Factors controlling Parasitism with special reference to the Cotton Boll Weevil. Journ. Econ. Entom., 1908, vol. i, pp. 315-323.

**Scott, Hugh.**—On certain *Nycteribiidae,* with descriptions of two new species from Formosa. Trans. Entom. Soc. Lond., 1908, pp. 359-370, plt. xviii.

**Silvestri, F.**—Liste des *Japygidae.* Ann. d. Sci. Nat. (Zool.), 1908, pp. 151-157, 17 figs.

**Smith, J. B.**—Notes on some *Cecropia* cocoons and parasites. Journ. Econ. Entom., 1908, vol. i, pp. 293-297.

**Townsend, C. H. T.**—A Record of Results from rearings and dissections of *Tachinidae*. U.S. Dept. Agric., Bur. of Entom., Tech. Ser., No. 12, pt. vi, 1908, pp. 95-118, figs. 25-30.

**Webster, R. L.**—The Eggs of *Empoasca mali*, Leb. Journ. Econ. Entom., 1908, vol. i, pp. 326, 327.

**Wesché, W.**—The systematic affinities of the *Phoridae* and of several Brachycerous families in Diptera. Trans. Entom. Soc. Lond., 1908, pp. 283-296, plt. vii.

## IV.—Agriculture and Horticulture.

**Berger, E. W.**—The Citrus Whitefly of Florida consists of two species. Journ. Econ. Entom., 1908, vol. i, pp. 324, 325.

**Chittenden, F. H.**—The Strawberry Weevil (*Anthonomus signatus*, Say.). U.S. Dept. Agric., Bur. of Entom., Circ. No. 21, rev. ed., 1908, pp 1-10, 5 figs.

**Chittenden, F. H.**—The Squash-Vine Borer (*Melittia satyriniformis*, Hbn.). U.S. Dept. Agric., Bur. of Entom., Circ. No. 38, rev. ed., 1908, pp 1-6, 2 figs.

**Chittenden, F. H.**—The Rose Slugs. U.S. Dept. Agric., Bur. of Entom., Circ. No. 105, 1908, pp. 1-12, 4 figs.

The term slugs is used here with about the same exactitude as the American entomologist uses the term "worm." The circular treats of three species of sawflies.

**Cook, A. J.**—Parasitic Control of Injurious Insects. Rpt. 34th Fruit Growers' Convention Calif., 1908, pp. 49-55.

**Evans, I. B. P.**—The Citrus Fruit-Rot caused by the Blue-Mould, *Penicillium digitatum* (Fr.), Sacc. Transv. Agric. Journ., 1908, vol. vii, pp. 60, 62, 2 plts.

**Evans, I. B. P.**—The New York Apple Tree Canker or Black Rot Fungus in South Africa. Transv. Agric. Journ., 1908, vol. vii, pp. 62-64, plt. 7.

**Evans, I. B. P.**—Potato Rot (*Nectria solani*, Pers.). Transv. Agric. Journ., 1908, vol. vii, pp. 64, 65, plt. 8.

**Felt, E. P.**—23rd Report of the State Entomologist, 1907. New York State Mus., Bull. 124, 1908, pp. 5-60, plts. 1, 2, and 1 fig.

**Forbes, S. A.**—Twenty-fourth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois. Pp. xvi + 168, 11 plts. Bloomington, 1908.

A report full of valuable information. Apart from the account of the excellent experimental work, there are numerous life-histories detailed and beautifully illustrated.

**Foster, E.**—The Introduction of *Iridomyrmex humilis* (Mayr) into New Orleans. Journ. Econ. Entom., 1908, vol. i, pp. 289-293.

**Gillette, C. P.**—Notes and Descriptions of some Orchard Plant Lice of the Family *Aphididae*. Journ. Econ. Entom., 1908, vol. i, pp. 302-310, plts. 5, 6.

**Gunn, D.**—Locust Destruction Work in the Transvaal. Transv. Agric. Journ., 1908, vol. vii, pp. 75-80, 2 maps.

**Gunn, D.**—Forecast of Areas in the Transvaal where eggs of Brown Locusts have been laid. Transv. Agric. Journ., 1908, vol. vii, pp. 81-83, 1 map.

**Howard, L. O.**—The importation of *Tetrastichus xanthomelaenae* (Rond.). Journ. Econ. Entom., 1908, vol. i, pp. 281-289, 1 fig.

Dr. Howard describes the steps that have been taken to introduce this parasite of the Elm leaf-beetle, *Galerucella luteola*.

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